RAS 11752

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May 25, 2006

VIA FEDERAL EXPRESS

Office of the Secretary
U.S. Nuclear Regulatory Commission
Washington, DC 20555–0001
Attention: Rulemaking and Adjudications Staff

Subject: Request for a Hearing and Petition to Intervene

Dear Mr. Secretary,

On behalf of Pilgrim Watch, I am enclosing the original and two copies of the following:

1. Request for a Hearing and Petition to Intervene;
2. Exhibits A through F for said Petition;
3. Certificate of Service;
4. Notice of Appearance, and
5. Declaration of Petitioner.

In addition, these documents are being filed electronically. Please file these documents and take appropriate steps to assure that this Request for a Hearing and Petition are processed in accordance with the Code of Federal Regulations. If you have any questions or problems with regard to this Petition, please let me know immediately. I look forward to and appreciate in advance your confirmation of the receipt of this filing.

Very truly yours,

Molly H Bartlett

TEMPLATE = SECY-037

SECY-02

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the matter of
Entergy Corporation
Pilgrim Nuclear Power Station
License Renewal Application

Docket # 50-293

May 25, 2006

REQUEST FOR HEARING AND PETITION TO INTERVENE BY PILGRIM WATCH

In accordance with the Nuclear Regulatory Commission's (NRC's) "Rules of Practice for Domestic Licensing Proceedings" in 10 CFR Part 2, Pilgrim Watch hereby submits contentions challenging the adequacy of Entergy's January 27, 2006 application for license renewal for Pilgrim Nuclear Power Station in Plymouth, Massachusetts. As demonstrated below, the contentions satisfy the NRC's admissibility requirements in 10 CFR §2.309.

I. Introduction

A petitioner for intervention is entitled to party status if he (1) establishes standing and (2) pleads at least one valid contention. *Carolina Power and Light Co. and North Carolina Eastern Municipal Power Agency* (Shearon Harris Nuclear Power Plant, Units 1 and 2), LBP-82-119A, 16 NRC 2069, 2070 (1982).

The Petitioners Have Standing:

Pilgrim Watch is a non-profit citizens' organization located at 148 Washington Street, Duxbury, Massachusetts, 02332, with at least two members who make their residences and places of occupation and recreation within ten (10) miles of Pilgrim Nuclear Power Station (hereinafter referred to as "Pilgrim"). Those members are Mary

Elizabeth Lampert, 148 Washington Street, Duxbury, Massachusetts 02332 and Molly Harding Bartlett, 52 Crooked Lane, Duxbury, Massachusetts 02332.

Under 10 CFR § 2.309 Petitioners have standing to intervene in the license renewal proceedings of Pilgrim because they live within 10 miles of the facility. For reactor construction and licensing proceedings, the NRC has recognized a presumption that people who live within close proximity of the facility (50 miles) have standing to intervene in the proceedings. Reactor license renewal proceedings should use the same presumption because during the renewal period the reactor can be subject to some of the same equipment failure and personnel error as during operations over the original license period. *Duke Energy Corp.* (Oconee Nuclear Station, Units 1, 2 & 3), LBP-98-33, 48 NRC 381, 385 n.1 (1998). Petitioners live and own property in Duxbury, Massachusetts which is within 10 miles of Pilgrim, and therefore have standing to intervene in this license renewal. Petitioners believe that their interests will not be adequately represented without this action to intervene, and without the opportunity to participate as full parties in this proceeding. Petitioners believe that if Pilgrim is allowed to operate for an additional twenty years without first resolving the Petitioners safety concerns, the nuclear plant may operate unsafely and pose an unacceptable risk to the environment and jeopardize the health, safety and welfare of Petitioners' members who live, recreate, conduct business and own property within the vicinity of the nuclear power station.

The Petitioners Have Pleaded Valid Contentions:

Under 10 CFR §2.309(a), the Licensing Board "will grant the request/petition if it determines that the requestor/petitioner has standing under the provisions of paragraph (d) of this section and has proposed at least one admissible contention that meets the requirements of paragraph (f) of this section." Because the NRC rules have made adjudicatory hearings in license renewals discretionary, and the requirements the rules place on citizens wishing to have their concerns addressed in a hearing are burdensome, the Licensing Board should take care not to exclude a party who is raising valid and significant safety concerns that are relevant to the renewal. In *Cincinnati Gas & Electric Co.* (William H. Zimmer Nuclear Power Station), ALAB-305, 3 NRC 8, 12 (1976) the

Board stated that since a mandatory hearing is not required at the operating license stage, Licensing Boards should "take the utmost care" to assure that the "one good contention rule" is met in such a situation because, absent successful intervention, no hearing need be held. In addition, a Licensing Board should not address the merits of a contention when addressing admissibility. *Public Service Co. of New Hampshire* (Seabrook Station, Units 1 and 2), LBP-82-106, 16 NRC 1649, 1654 (1982). The basis for a contention may not be undercut, and the contention thereby excluded, through an attack on the credibility of the expert who provided the basis for the contention. *Cleveland Electric Illuminating Co.* (Perry Nuclear Power Plant, Units 1 and 2), LBP-82-98, 16 NRC 1459, 1466 (1982).

Petitioners hereby submit five valid contentions for consideration by this Board:

1. The Aging Management Plan does not adequately inspect and monitor for leaks in all systems and components that may contain radioactively contaminated water.
2. The Aging Management Plan is inadequate because it does not adequately monitor for corrosion in the Drywell Container.
3. The Environmental Report is inadequate because it ignores the true off-site radiological and economic consequences at Pilgrim in its Severe Accident Mitigation Alternative (SAMA) analysis.
4. The Environmental Report fails to address Severe Accident Mitigation Alternatives (SAMAs) which reduce the potential for spent fuel pool water loss and fires.
5. New Information shows that another twenty years of operations at Pilgrim may have greater off-site radiological impacts on human health than was previously known.

Two of these contentions concern defects in the Applicant's Aging Management Plan, and three concern defects in the Applicant's Environmental Report. All of these contentions are admissible and meet the requirements of 10 CFR § 2.309.

II. Technical Contentions Concerning Applicant's Aging Management Plan

Contention 1: The Aging Management Plan Does Not Adequately Inspect and Monitor For Leaks in All Systems and Components That May Contain Radioactively Contaminated Water

1.0 Contention

The Aging Management program proposed in the Pilgrim application for license renewal is inadequate because (1) it does not provide for adequate inspection of all systems and components that may contain radioactively contaminated water and (2) there is no adequate monitoring to determine if and when leakage from these areas occurs. Some of these systems include underground pipes and tanks which the current aging management and inspection programs do not effectively inspect and monitor.

1.1 The Contention is within the Scope of these proceedings

10 CFR §2.309(f)(iii) requires that the Petitioner "Demonstrate that the issue raised in the contention is within the scope of the proceeding." In proceedings concerning the renewal of an operating license, the scope is limited to "a review of the plant structures and components that will require an aging management review for the period of extended operation and the plant's systems, structures, and components that are subject to an evaluation of time limited aging analysis." *See Florida Power and Light Co.* (Turkey Point Nuclear Generating Plant, Units 3 and 4), CLI-00-23, 52 NRC 327, 329 (2000). The inspection and monitoring program for corrosion of systems and components containing radioactive water is within the scope of these proceedings. In reactor license renewals, 10 CFR § 54 requires the Applicant to submit as part of its application an Aging Management Program for all passive systems at the facility, which includes the methods they use to monitor the condition of important equipment so that they can make repairs and replacements before safety margins are compromised. In order to renew its license for another 20 years Pilgrim is required, under 10CFR§54.21 to demonstrate that for each structure and component identified in that section the effects of

aging will be adequately managed for the period of extended operation. The Pilgrim Nuclear Power Plant Application for License Renewal (Application) includes a list of systems that require aging management. Among them are pipes and tanks. (Application, B.1.2 Buried Piping and Tanks Inspection, page B-17. The aging of materials is important during the period of extended operation of a plant applying for license renewal because certain components may have been designed upon an assumed service life. *Florida Power and Light Co.* (Turkey Point Nuclear Generating Plant, Units 3 & 4), CLI-01-17, 54 NRC 3, 7 (2001). Deficiencies in the Aging Management Plan that encompass the detection of leaks in systems containing radioactive water could endanger the safety and welfare of the public and are therefore within the scope of a re-licensing hearing.

1.2 The issue raised in the Contention is Material to the findings of these proceedings

10 CFR §2.309(f)(iv) requires that the Petitioner "Demonstrate that the issue raised in the contention is material to the findings the NRC must make to support the action that is involved in the proceeding." In discussing the materiality requirement, the Atomic Safety and Licensing Board (ALSB) considering the license renewal for Millstone Nuclear Power Station stated "In order to be admissible, the regulations require that all contentions assert an issue of law or fact that is material to the outcome of a licensing proceeding; that is, the subject matter of the contention must impact the grant or denial of a pending license application. Where a contention alleges a deficiency or error in the application, the deficiency or error must have some independent health and safety significance." *In the Matter of Dominion Nuclear Connecticut, Inc.*(Millstone Nuclear Power Station, Units 2 and 3) Docket Nos. 50-336-LR, 50-423-LR ASLBP No. 04-824-01-LR July 28, 2004, p. 7. *See Private Fuel Storage, L.L.C.* (Independent Spent Fuel Storage Installation), LBP- 98-7, 47 NRC 142, 179-80 (1998), aff'd in part, CLI-98-13, 48 NRC 26 (1998). The sufficiency of the Aging Management Plan for detecting possible leaks in systems and components that contain radioactive water is material to the

renewal of this license because that deficiency could significantly impact health and safety.

1.3 There is a Substantial Basis for this Contention

As described below, recent events around the country have demonstrated that leaks of underground pipes and tanks can result in the release of massive amounts of radioactive materials into the ground water. Exposure to this radiation can be a threat to human health, and is a violation of NRC Regulations. Because older plants are more likely to experience corrosion and leakage problems, and low energy radionuclides can speed up the rate of corrosion, Pilgrim should be required, as part of its Aging Management Program, to adequately inspect and monitor any systems and components that carry radioactive water. The Aging Management Plan should be revised to include this inspection and monitoring before a license renewal is granted.

1.3.1 Recent events in several U.S. nuclear facilities have demonstrated that undetected leaks in underground pipes and buried tanks can cause the release of radioactive materials into the ground

Over the last decade a series of events, occurring at a quickening pace and with increasing magnitude, have raised serious questions about whether nuclear facilities are in compliance with federal regulations governing the release of radioactive materials into the environment. As outlined in Exhibit A, at least eight events have occurred where radioactively contaminated water has leaked into the ground from spent fuel pools, underground pipes and potentially from other systems and components, and remained undetected for as long as 12 years. The most recently discovered leak, the eighth event identified, occurred in March 2006 at Palo Verde Nuclear Generating Station in Arizona. The Arizona Republic reported March 4, 2006 that, "Arizona Public Service Co. discovered radioactive water near a maze of underground pipes at the Palo Verde Nuclear Generating Station...and tests confirmed that the water contains more than three times the acceptable amount of tritium." *Radioactive water found at Palo Verde*, Ken Alltucker

The Arizona Republic (Mar. 4, 2006). The most alarming aspect of these discoveries has been that they have usually been detected more by happenstance than by rigorous monitoring. In all of these cases, a small leak undetected for an extended period of time permitted large amounts of contaminated water to enter the ground around the facilities.

In 2004, the owner of the Dresden Nuclear Power Plant in Illinois, which like Pilgrim is a BWR Mark I containment facility, discovered a leak from an underground section of piping that carried water with a higher than normal level of tritium. The 267,000 gallons of contaminated water leaked into a 30 foot area that contained multiple storm drains that ultimately drained to the nearby river. In December 2005, tritium was detected in a drinking water well at a home near the Braidwood Nuclear Plant in Illinois. The "initial evaluation indicated that the tritium in the groundwater was a result of past leakage from a pipe which carries normally non-radioactive circulating water discharge to the Kankakee River, about five miles from the site. Several millions [sic] gallons of water leaked from the discharge pipe in 1998 and 2000."[1]

In January, 2006, a coalition of citizens' groups filed a Petition pursuant to 10 CFR §2.206, to ask the NRC take action to require nuclear facilities to address longstanding leakage of contaminated water. *Petition Pursuant To 10 CFR 2.206 – Enforcement Action – Longstanding Leakage of Contaminated Water* (January 25, 2006). Petitioners are party to that enforcement action and understand that the Commission is aware of potential problems with leaking underground pipes and spent fuel pools, and that measures are being considered to require monitoring and inspection to prevent long term leakage in the future. It is the Board's practice to disallow contentions where the issue is or is about to be considered as part of a rule-making, but contentions on "generic issues" which are not and are not about to become the subject of rulemaking appear to be permitted. *Potomac Electric Power Co.* (Douglas Point Nuclear Generating Station, Units 1 & 2), ALAB-218 8 AEC 79 (1974). *See Metropolitan Edison Co.* (Three Mile Island Nuclear Station, Unit 1) LBP -83-76, 18 NRC 1266, 1271 (1983). Petitioners are not aware of any proposed rulemaking on this issue at this time. In addition, any action taken by the NRC in response to the 2.206 Petition will not likely be part of the Aging

[1] Preliminary Notification of Event or Unusual Occurrence PNO-RIII-05-016A dated December 7, 2005, by the Nuclear Regulatory Commission, "Potential Off-site Migration of Tritium Contamination (Update)."

Management Plans of older plants seeking license renewal under 10 CFR § 54, and thus will not be directly linked to permits for license renewal. Petitioners contend that a forty year old facility has aging related problems which are unique to older facilities and should be dealt with as part of the Aging Management Program during the relicensing of that facility. In addition, Pilgrim has site specific attributes due to its history and location which make leaks from components and systems such as underground piping more likely and more difficult to detect.

1.3.2 Exposure to radioactive materials in the ground water is a threat to human health and a violation of 10 CFR §20.1302 and §50 Appendix A

Exposure to radiation, including tritium, can cause cancer, disease, genetic mutations and birth defects. Since tritiated water is processed by plants, animals and humans like ordinary water, the tritium in it can become transformed into other chemicals, such as proteins, needed by the body. Organically bound tritium can become part of the DNA molecule and can affect developing fetuses.[2] Based on information now available, some scientists have called for a reevaluation of allowed doses of tritium to the public.[3] A report prepared by Drs. Sauer, Burns and Kron for the Governor of Illinois, March 30, 2006 on the health concerns regarding the health of communities in the vicinities of the Braidwood and Dresden nuclear power plants noted that accidental releases of radionuclides from Braidwood have occurred since the mid-1990's with multiple spills up to 3 million gallons. The Illinois Environmental Protection Agency acknowledged water levels of tritium beneath Dresden were 5,000 times the acceptable level. The data from the Illinois Department of Public Health indicated that infant mortality, low birth weight, and birth defects increased substantially in Grundy County (which encompasses the Braidwood Plant) during the time span of the spills – from the

[2] Statement on Tritium, by Arjun Makhijani, Ph.D., 6 February 2006 This statement was prepared for a February 7, 2006, public forum in Godley, Illinois. The forum concerned the discharge of contaminants into groundwater by a nuclear power plant in Braidwood, Illinois.

[3] Arjun Mahajani, IEER, Letter to BEIR VII Committee (Biological Effects of Ionizing Radiation of the National Academy of Sciences, May 23, 2003, Harrison, J.D., A. Khursheed, and B.E. Lambert, "Uncertainties in Dose Coefficients for Intakes of Tritiated Water and Organically Bound Forms of Tritium by Members of the Public," *Radiation Protection Dosimetry*, Vol. 98, No. 3, 2002, pp. 299-311.

early 1990s to the late 1990s. The decline in health occurred despite improvements in prenatal care. During the most recent reporting period, the rate of infant deaths was twice as high in Grundy County as it had been in the early 1990's. During the same time period, the 24 communities within 15 miles of the reactors experienced a rise in leukemia by 43% and in the rate of cancers of the nervous system by 75%. The Aging Management Program at Pilgrim needs to be proactive at detecting leaks so that they can be discovered before they percolate into local groundwater or Cape Cod Bay and result in tragedies like those that have occurred in Grundy County. Although the above case involved tritium, any number of different isotopes could be released and migrate off-site through the groundwater. Strontium-90, for example, is being released along with tritium at Indian Point into the Hudson River. *Indian Point officials zero in on leak: Source of Radioactive Strontium 90 Turning up in Groundwater Believed to be from Spent Fuel Rod Pool*, Associated Press (May 12, 2006).

The National Academy of Sciences' BEIR VII report concluded that there is no safe dose of radiation and that it is approximately three times more dangerous than current NRC Regulations predict. *Health Risks from Exposure to Low Levels of Ionizing Radiation: BEIR VII Phase 2 (2006),* Occupational Radiation Studies, Chapter 8, National Academies Press, 2006. Additional exposures from undetected leaks are of special concern to communities affected by Pilgrim because it has already experienced past radiation releases and is an aging population and therefore more susceptible to environmental assaults, as discussed in Contention 5.

1.3.3 Aging nuclear plants are more likely to experience corrosion related leaks

Recent discoveries of leaked radioactive water in other nuclear facilities have made it clear that current methods for monitoring systems and components such as buried pipes and underground tanks are inadequate. In addition, the older the structure in question, the more likely it is for leakages to occur. *See in general U.S. Nuclear Plants in the 21st Century: the risk of a lifetime*, by David Lochbaum, Union of Concerned Scientists. (May 2004). To describe the likelihood of aging related problems in nuclear plants, Lochbaum uses the "Bathtub Curve," which was developed by NASA scientists studying statistically the lifetimes of both living and non-living things. *"Using*

Reliability-Centered Maintenance As The Foundation For An Efficient And Reliable Overall Maintenance Strategy," National Aeronautics and Space Administration (NASA), 2001. The curve, which is a graph of failure rate versus age, shows that after a relatively stable (bottom of the bathtub) period in the middle life of the subject, a steep rise in age-related failures occurs towards the end of its life. "The right-hand side of the curve, labeled Region C, is the wear-out phase. Due to aging, it takes less stress to cause failure in this phase, just as older people are more prone to breaking bones in a fall than younger people. Thus, the chances of failure increase with time spent in Region C." (Union of Concerned Scientists Report, *supra*, at 4). The renewal period of a nuclear plant would be its Region C, or wear-out phase. "As reactors approach or enter Region C [the wear-out phase] and become more vulnerable to failure, aging management programs monitor the condition of equipment and structures so as to affect repairs or replacements before minimum safety margins are compromised. Unfortunately, age-related degradation is being found too often by failures than by condition-monitoring activities." *Id.* at 20. Therefore condition-monitoring activities in many facilities are inadequate.

1.3.4 Corrosion can be induced by low energy radionuclides

A recent study shows that radioactive water carried in underground pipes of an aging plant can speed up corrosion of already worn pipes. Nuclear power plants emit radiation and particles across a range of energies. This radiation can cause corrosion in critically important parts of the plant, which can lead to efficiency and safety problems. Gamma rays and neutrons have the highest energies and can break the metal bonds in interior metallic structures causing damage quickly and in easily monitored ways. Consequently these types of radiation and the best alloys to use to mitigate their effects have been extensively researched and their findings applied. However, the same is not true of low energy radiation which effects metal structures in a different way but can still cause appreciable and expensive corrosion. Low energy radiation degrades the passive oxide layers that protect metals. Without this protective layer the metals are easily corroded. G. Bellanger, *Corrosion Induced by Low Energy Radionuclides: Modeling of*

Tritium and Its Radiolytic and Decay Products Formed in Nuclear Installations (Elsevier Publications, 2006), ISBN 0 08 0445101.

1.3.5 The potential risk of leaks at Pilgrim might be increased by the inadvertent past use of counterfeit or substandard parts

Pilgrim is also specifically vulnerable to undetected leaks in its underground pipes and tanks because it has nonconforming pipe fittings and flanges. The United States Government Accounting Office [4] reported that PNPS is suspected of having received counterfeit or substandard pipe fittings and flanges. This could make leaks of contaminated water more likely. There is no evidence in the applicant's filing that a thorough investigation has occurred to determine precisely which pipe fittings and flanges are substandard and whether they have been upgraded to meet standards. The Aging Management Program should be adjusted to either require upgrading or replacing those parts or to treat those components and systems with substandard parts more conservatively in the Aging Management Program by requiring, for example, more frequent and thorough inspections. The aging management analysis for structures and components that contain radioactively contaminated water, such as underground pipes, is necessarily deficient because it is not possible to perform a probabilistic risk assessment when components are substandard.

1.3.6 The Aging Management Program at Pilgrim does not provide adequate inspection of systems and components such as underground pipes and tanks

The Applicant describes the inspection and aging management programs for underground pipes and tanks at Pilgrim in Appendix A and B of its renewal filing. Appendix A.2.1.2. "Buried Pipes and Tanks Inspection Program page A-14" states that buried components are inspected when excavated during maintenance and if "trending" identifies a susceptible location, this area with a history of corrosion might have

[4] United States General Accounting Office, Report to the Chairman, Subcommittee on Oversight and Investigations, Committee on Energy and Commerce, House of Representatives, Nuclear safety and Health Counterfeit and Substandard Products Are A Government Wide Concern, GAO/RCED-91-6, October 1990.

additional inspections, coating or replacement. Focused inspections will be performed within 10 years of the license renewal unless an "opportunistic inspection" which allows assessment of pipe condition without excavation, occurs within the ten-year period.

Appendix B describes the Aging Management Program for buried pipes and tanks. This section also says that buried components will be inspected when excavated during maintenance, and that a focused inspection will be performed within ten years unless an opportunistic inspection occurs within this period. The program is consistent with NUREG-1801, except that Appendix B also provides that "Inspections via methods that allow assessment of pipe condition without excavation may be substituted for inspections requiring excavation solely for the purposes of inspection." These latter inspections can include phased array Ultrasonic Testing (UT) technology that provides indication of wall thickness for buried piping without excavation. The application says that use of such methods to identify the effects of aging is preferable to excavation for visual inspection, which could result in damage to coatings or wrapping. (Application, B.1.2, page B-17). However, UT methods to measure the thickness of the component, as stated by the applicant would not necessarily detect a hole or crack in the component. And "array UT technology" implies testing only selected areas of the pipe/tank, not testing along the entire structure's surface area. Simply testing selected areas can miss holes, cracks or vulnerably thin sections of these components. The application also states that these methods have not been used in the past, so there is no operating experience to rely on.

Clearly inspections that might only occur every ten years are insufficient if there is a potential leak of radioactive water from corroded components that could be migrating off-site. "Opportunistic inspections" that might occur more often than ten years give the appearance the matter of discovering leaks is being left to chance. The UT technology that Pilgrim might use is untested by plant operating experience. There should be regular and frequent inspections of all components that contain radioactive water in this aging plant.

1.3.7 The Aging Management Program at Pilgrim does not provide adequate monitoring to ensure that leaks from systems and components such as underground pipes and tanks are detected

Nuclear Power Plants have underground pipes containing large quantities of radioactively contaminated water. Despite the fact that some of these pipes and tanks might not be physically examined for ten years, it does not appear that Pilgrim is relying on monitoring test wells around these pipes and tanks to detect leaks. Large leaks in these pipes may be detected by a drop in water level in a tank or via increased makeup to a tank. However, smaller leaks, if undetected, can eventually result in much larger releases of radioactive liquid into the ground, and are more difficult to detect. A small leak might be masked within the accuracy of the level instruments for tanks, and the difficulty of accounting for routine flows into and out of the tanks each day. Even if monitoring wells are in use, they are usually placed in such as way as to detect only large spills from accidental overflows and valve malfunctions, not plumes emanating from smaller leaks over a long period of time. In addition, unless they are sampled often, small but steady leaks could go undetected for months. The topography of the Pilgrim site is such that, were a leak to develop in an underground pipe or tank, the contaminated water would most likely migrate seaward and drain into the ocean. Dilution of an unknown quantity of radioactive water into Cape Cod Bay is not permitted by current regulations. The only effective way to monitor for such an occurrence would be to have on-site monitoring wells located between Pilgrim and the ocean.[5] A suitable array of wells, sampled regularly, could be used to test that the inspection program is working properly. In most of the recent cases of leaked radioactive water, the leaks were detected by monitoring wells, but often not until long after the leaks occurred. It is unrealistic to expect to happen upon a leaking pipe during routine maintenance activities, particularly if

[5]Topopgraphy source: Pilgrim Nuclear Power Station, Boston Edison Company Docket No. 50-293, May 1972 –U.S. Atomic Energy Commission, Division of Radiological and Environmental Protection, Final EIS "The station site is along the rocky western shoreline of Cape Cod Bay. The geology of the site is recognized as primarily glacial deposits. The natural surface stratum in the station area consists of approximately 20 feet of silty and clayey fine sands with scattered boulders. Bedrock is about 30 to 90 feet below mean sea level." P. 9 "Surface topography is such that surface drainage from the station is seaward and surface water will not leave the Station property otherwise." P. 10.

those activities only take place every ten years. In his recommendations for managing aging nuclear power plants, Lochbaum says that sometimes the proper inspection methods are used but in the wrong places, or the wrong inspection methods are used in the right places. To lower the chances of overlooking serious problems, there should be diverse inspections methods used routinely when looking in the right spots. USC Report, *supra* at 21. Monitoring wells in suitable locations at Pilgrim should be used as part of the aging management program to supplement visual and ultrasonic tests.

1.3.8 Current NRC Regulations require Pilgrim to improve its current inspection and monitoring programs

Current regulations already require the Applicant to have in place an effective program for monitoring radiation on-site and off-site.[6] Although on-site monitoring wells to detect radiation in groundwater are not specifically required in these regulations (unless the water on-site is used for drinking, which it is not at Pilgrim), recent events make such a scheme a natural addition to the Pilgrim Aging Management Plan. 10 CFR § 20.1302 and §50 Appendix A Criterion 60 require that NRC's licensees demonstrate that effluents, including those from 'anticipated operational occurrences,' do not expose members of the public to excessive radiation doses.[7] Effective monitoring systems are

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[6] **10 CFR § 20.1302 Compliance with dose limits for individual members of the public.**
(a) The licensee shall make or cause to be made, as appropriate, surveys of radiation levels in unrestricted and controlled areas and radioactive materials in effluents released to unrestricted and controlled areas to demonstrate compliance with the dose limits for individual members of the public in § 20.1301.
10 CFR § 50 Appendix A
Criterion 60--Control of releases of radioactive materials to the environment. The nuclear power unit design shall include means to control suitably the release of radioactive materials in gaseous and liquid effluents and to handle radioactive solid wastes produced during normal reactor operation, including anticipated operational occurrences. Sufficient holdup capacity shall be provided for retention of gaseous and liquid effluents containing radioactive materials, particularly where unfavorable site environmental conditions can be expected to impose unusual operational limitations upon the release of such effluents to the environment.
Criterion 64--Monitoring radioactivity releases. Means shall be provided for monitoring the reactor containment atmosphere, spaces containing components for recirculation of loss-of coolant accident fluids, effluent discharge paths, and the plant environs for radioactivity that maybe released from normal operations, including anticipated operational occurrences, and from postulated accidents.

[7] **10 CFR § 20.1302 Compliance with dose limits for individual members of the public.**
(a) The licensee shall make or cause to be made, as appropriate, surveys of radiation levels in unrestricted and controlled areas and radioactive materials in effluents released to unrestricted and controlled areas to demonstrate compliance with the dose limits for individual members of the public in § 20.1301.

required in order comply with these regulations. While leaks of radioactively contaminated water into the ground for extended periods of time may not have been operational occurrences anticipated when the facilities were initially designed and licensed, they can scarcely be "unanticipated" following the series of occurrences summarized in Exhibit A. As those events demonstrated, unless nuclear facilities aggressively monitor for leaks both off-site and on-site, a leak can go undetected for years, and potentially life threatening releases of radiation can migrate off-site before any problem is detected.

1.4 Conclusion: The Aging Management Plan should include more effective methods to inspect and monitor for leaks of radioactive water from systems and components including underground pipes and tanks before license renewal is granted

The Aging Management of systems and components, including underground pipes and tanks, which may carry radioactively contaminated water is within the scope of this license renewal application. Management to detect possible leaks is a site specific safety issue which has not been properly addressed in the Pilgrim application for license

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(b) A licensee shall show compliance with the annual dose limit in § 20.1301 by--
(1) Demonstrating by measurement or calculation that the total effective dose equivalent to the individual likely to receive the highest dose from the licensed operation does not exceed the annual dose limit; or
(2) Demonstrating that--
(i) The annual average concentrations of radioactive material released in gaseous and liquid effluents at the boundary of the unrestricted area do not exceed the values specified in table 2 of appendix B to part 20; and
(ii) If an individual were continuously present in an unrestricted area, the dose from external sources would not exceed 0.002 rem (0.02 mSv) in an hour and 0.05 rem (0.5 mSv) in a year.

10 CFR § 50 Appendix A

Criterion 60--Control of releases of radioactive materials to the environment. The nuclear power unit design shall include means to control suitably the release of radioactive materials in gaseous and liquid effluents and to handle radioactive solid wastes produced during normal reactor operation, including anticipated operational occurrences. Sufficient holdup capacity shall be provided for retention of gaseous and liquid effluents containing radioactive materials, particularly where unfavorable site environmental conditions can be expected to impose unusual operational limitations upon the release of such effluents to the environment.

Criterion 64--Monitoring radioactivity releases. Means shall be provided for monitoring the reactor containment atmosphere, spaces containing components for recirculation of loss-of coolant accident fluids, effluent discharge paths, and the plant environs for radioactivity that may be released from normal operations, including anticipated operational occurrences, and from postulated accidents.

renewal, and has not been adequately dealt with by the Agency in a generic way at this time. The failure to address this issue before license renewal is granted could result in significant harm to the health and safety of the public. The Aging Management Plan should more thoroughly address this issue before a license extension for Pilgrim is granted.

Contention 2: The Aging Management Plan at Pilgrim Fails to Adequately Monitor for Corrosion in the Drywell Liner

2.0 Contention

The Aging Management program proposed in the Pilgrim application for license renewal fails to adequately assure the continued integrity of the drywell liner, or shell, for the requested license extension. The drywell liner is a safety-related containment component, and its actual wall thickness should be confirmed by periodic ultrasonic testing (UT) measurements at all critical areas, including those which are inaccessible for visual inspection. The current plan does not adequately monitor for corrosion in these inaccessible areas, nor does it include a requirement for a root cause analysis when corrosion is found.

2.1 The Contention is within the Scope of these proceedings

10 CFR 2.309(f)(iii) requires that the Petitioner "Demonstrate that the issue raised in the contention is within the scope of the proceeding." In proceedings concerning the renewal of an operating license, the scope is limited to "a review of the plant structures and components that will require an aging management review for the period of extended operation and the plant's systems, structures, and components that are subject to an evaluation of time limited aging analysis." *See Florida Power and Light Co.* (Turkey Point Nuclear Generating Plant, Units 3 and 4), CLI-00-23, 52 NRC 327, 329 (2000). An Aging Management Program that ensures the integrity of the drywell liner for the extended operational life of the plant is within the scope of these proceedings. In reactor license renewals, 10 CFR § 54 requires the Applicant to submit as part of its application an Aging Management Program for all passive systems at the facility, which includes the methods they use to monitor the condition of important equipment so that they can make repairs and replacements before safety margins are compromised. In order to renew its license for another 20 years Pilgrim is required, under 10CFR§54.21, to demonstrate that for each structure and component identified in that section the effects of aging will be adequately managed for the period of extended operation. Included in the list of systems

that require aging management is the drywell. Application Appendix A.2.1.17 (Inservice Inspection – Containment Inservice Inspection (CII) Program. The aging of materials is important during the period of extended operation of a plant applying for license renewal because certain components may have been designed upon an assumed service life of forty years. *Florida Power and Light Co.* (Turkey Point Nuclear Generating Plant, Units 3 & 4), CLI-01-17, 54 NRC 3, 7 (2001). A deficiency in the Aging Management Plan that includes the inspection of the drywell liner for corrosion and thinning could endanger the public safety and welfare and is within the scope of a re-licensing hearing.

2.2 The issue raised in the Contentions is Material to these proceedings

10 CFR 2.309(f)(iv) requires that the Petitioner "Demonstrate that the issue raised in the contention is material to the findings the NRC must make to support the action that is involved in the proceeding." In discussing the materiality requirement, the Atomic Safety and Licensing Board considering the license renewal for Millstone Nuclear Power Station stated, "In order to be admissible, the regulations require that all contentions assert an issue of law or fact that is material to the outcome of a licensing proceeding; that is, the subject matter of the contention must impact the grant or denial of a pending license application. Where a contention alleges a deficiency or error in the application, the deficiency or error must have some independent health and safety significance." *In the Matter of Dominion Nuclear Connecticut, Inc.* (Millstone Nuclear Power Station, Units 2 and 3) Docket Nos. 50-336-LR, 50-423-LR ASLBP No. 04-824-01-LR July 28, 2004, p. 7. See Private Fuel Storage, L.L.C. (Independent Spent Fuel Storage Installation), LBP- 98-7, 47 NRC 142, 179-80 (1998), aff'd in part, CLI-98-13, 48 NRC 26 (1998). The sufficiency of the Aging Management Plan for detecting possible corrosion and thinning of the drywell liner is material to the renewal of this license. The Aging Management Plan is deficient and that deficiency could significantly impact public health and safety.

2.3 There is a Substantial Basis for the Contention

A contention about a matter not covered by a specific rule need only allege that the matter poses a significant safety problem. *Duke Power Co.* (Catawba Nuclear

Station, Units 1 and 2), LBP-82-116, 16 NRC 1937, 1946 (1982). The drywell liner has been identified by the NRC and the Applicant as a safety-related structure to be maintained both as a pressure-related boundary and for structural support. It is required to contain and control the release of fission products to the Reactor Building in the event of a Design Basis Accident, including a Loss-Of-Coolant-Accident (LOCA) so that the off-site radiation dose to the surrounding communities remains within NRC designated limits. This structure is therefore vital to the protection of the health, safety and welfare of the public and Petitioners' members. Recent events cited herein have demonstrated that the corrosion of Mark I Drywells is a major safety issue that is not addressed by current NRC Guidance Documents. Pilgrim has a history of corrosion in different areas of the drywell and there has been a reduction in drywell wall thickness. Despite this fact, the Aging Management Program does not adequately monitor for corrosion in the drywell and drywell wall thickness. The Aging Management Program should address this issue, and perform root cause analysis where any corrosion is found, before a license renewal is granted.

2.3.1 The NRC Has Acknowledged that Corrosion of Mark I Drywells is a Major Safety Related Issue that is not Addressed by Current NRC Guidance Documents

In 1986, the NRC notified the nuclear industry of the potential for corrosion of the drywell liner. NRC Information Notice 86-99 (IN 86-99). The drywell shell at the Oyster Creek Generating Station, which, like Pilgrim NPS is a GE Mark I BWR, was the first place this problem came to the NRC's attention. At that power station, water leakage was identified in the gap between the reactor's drywell liner and the concrete shield wall. The plant operator made a series of ultrasonic test (UT) measurements which showed localized corrosion (pitting) in the steel containment with a reduction in the liner wall thickness of more than ¼ inch. Despite efforts by the operator to remediate the conditions which led to this corrosion it continued to occur, such that the NRC stated in its 1992 Safety Evaluation of Oyster Creek's Drywell Integrity, ". . . An examination of

the results of consecutive UT measurements confirmed that the corrosion is continuing. There is concern that the structural integrity of the drywell cannot be assured. . ."[8]

Recently the NRC has held a series of meetings with stakeholders to discuss the problem of corrosion of Mark I steel containment drywell shells. In these meetings NRC staff have acknowledge the need for monitoring and analysis of corrosion problems as part of license renewals and they have stated that this is an issue of generic concern to Mark I reactors. At the meeting on January 31, 2006,[9] one of the NRC staff, Linh Tran, made it clear in her remarks that the NRC staff have concluded that the corrosion of the Mark I reactor drywell liner is a major safety-related issue that has not received sufficient attention to date. In addition, she explained that the Generic Aging Lesson Learned ("GALL") report does not provide sufficient guidance for detecting and monitoring potential corrosion in the drywell shell, particularly in inaccessible areas, for example, when the drywell shell area is surrounded by concrete structure and the distance between the shell and surrounding concrete is too small for performing visual examinations.

The NRC staff has proposed a number of modifications to GALL, highlighting the need to evaluate both the corrosion itself and the potential sources of water, including cracks in the concrete containment and the refueling seal at the top of the drywell liner. In particular, the NRC staff believes the refueling seal must be brought within the scope of license renewal. It was stated in that meeting that for inaccessible areas where there was a potential for corrosion, UT measurements of the thickness of the drywell would be required. The NRC staff stated that all Mark I reactors have a potential problem and require evaluation.[10]

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[8] Safety Evaluation by the Office of Nuclear Reactor Regulation, Drywell Structural Integrity, Oyster Creek Nuclear Generating Station, GPU Nuclear Corporation, United States Nuclear Regulatory Commission, April 24, 1992, Introduction.

[9] NRC Conference Call January 31, 2006 to discuss the proposed interim staff guidance for license renewal associated with Mark I steel containment drywell shell. Power point Presentation and discussion by Ms Linh Tran (see NIRS Oyster Creek Motion for Leave to Add Contentions or Supplement, Feb 7, 2006)

[10] Staff proposed adding the following text to NUREG-1800:
Operating experience in the Mark I steel containments indicate that when water is discovered in the bottom outside areas of the drywell (including that in the sand- pocket areas), the likely cause is the water seeping through the space between the drywell shell and the shield concrete. The source of the water has been shown to be the seal between the refueling cavity and the drywell. GALL Report recommends root cause analysis and further evaluation, when potential for corrosion is indicated in the inaccessible areas of the drywell.

2.3.2 Current NRC Guidance Documents do not Adequately Address Corrosion of the Drywell Liner

The meetings of January 31, 2006 and March 23, 2006 were held by the NRC to introduce to stakeholders the topic of a potential License Renewal Interim Staff Guidance (LR-ISG) on the topic of Corrosion of Mark I Drywell Shells. On March 23rd, the Nuclear Energy Institute (NEI) outlined its reasons for thinking such an ISG is unnecessary. Despite this, on May 9, 2006, the NRC published proposed interim staff guidance on the aging management of drywell shells for license renewals. *Proposed License Renewal Interim Staff Guidance LR–ISG–2006–01: Plant-Specific Aging Management Program for Inaccessible Areas of Boiling Water Reactor Mark I Steel Containment Drywell Shell Solicitation of Public Comment*, 71 No.89 Fed. Reg. 27010 (proposed May 9, 2006). Public comments will be submitted until June 8, 2006 at which time the Commission will begin to make a determination about the proposed LR-ISG. Petitioners have included this proposed guidance document in Exhibit B.

Petitioners seek to intervene on the issue of drywell corrosion because the license renewal process for Pilgrim has already begun and will likely be completed before a final Staff Guidance on this problem is issued. All stakeholders including the NRC, the NEI and public advocacy groups acknowledge the seriousness of the potential for drywell corrosion. The Pilgrim Application for License Renewal does not adequately address this issue, and neither do the NRC's guidance documents and regulations. Unless Petitioners are allowed to intervene, using their experts and documentation, these concerns will not be adequately addressed as part of the Pilgrim license renewal. Although the issue of drywell corrosion has now clearly been brought to the attention of the NRC staff, the prospect of future Staff Guidance should not preclude Petitioners' intervention on this issue. "Participation of the NRC Staff in a licensing proceeding is not equivalent to participation by a private intervenor." *Washington Public Power Supply System* (WPPSS Nuclear Project No.3), ALAB-747, 18 NRC 1167, 1175-1176 (1983).

2.3.3 Pilgrim has a history of corrosion in different areas of the drywell, and there has been a reduction in drywell wall thickness

In Appendix B of the Application for License Renewal, the Applicant outlines the Operating Experience at Pilgrim, including problems that were detected and remedied. Some of these are listed below.[11] In the cases cited, both the lack of evident corrosion and the discovery of corrosion are described as evidence that the aging management program is working. "Absence of significant corrosion provides evidence that the program is effective for managing loss of material for the drywell spray header." (Application, B-84). "Identification of degradation and corrective action prior to loss of intended function provide evidence that the program is effective for managing aging effects." (Application, B-56). However, the fact that the operator came across corrosion and degradation in some instances does not prove their program is working and detecting *all* degradation and aging effects. Rather it proves is that there is indeed corrosion. Arguably the only conclusion that can be drawn from these operating experiences is that Pilgrim has been experiencing corrosion in some of the highly critical regions of the drywell, including enough to impact the thickness of the drywell liner.

As discussed in Contention 1, aging nuclear plants are more likely to experience failures including corrosion. Nuclear reactors have three stages of plant life time: the break-in phase [region A], mid-life phase [region B] and the wear-out phase [region C]. The risk profile for these phases of life curves like a bathtub. "The chances of failure

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[11] Operating Experience – page B-57-58
In 1999, the below-water region in all 16 torus bays as well as the drywell to torus vent areas with water accumulation were inspected. Results revealed areas of defects such as depleted zinc, localized pitting corrosion, and minor surface rusting. Degraded areas were re-coated to prevent further corrosion and re-examined. Identification of degradation and corrective action prior to loss of intended function provide evidence that the program is effective for managing aging effects; An IWE visual exam in 1999 detected loose torus anchor bolt extensions and baseplate corrosion exceeding acceptance criteria. Bolt extensions were tightened. Corrosion was accepted by evaluation. Identification of degradation and corrective action prior to loss of intended function provide evidence that the program us effective for managing aging effects; During RFO14 (April 2003) ultrasonic thickness examination of the torus shell, several measurements were below the nominal wall thickness of 0.629". Since the measurements were all greater than the minimum allowable thickness of 0.563", no further action was taken. CII examinations will continue to monitor thickness of the torus shell. Identification of degradation and corrective action prior to loss of intended function provide evidence that the program is effective for managing aging effects. Results of the CII general visual walkdown of primary containment during RFO14 (April, 2003) were compared with those from the previous inspection. The only new indication was in the CRD penetration area, where there is some surface corrosion but it is not significant and is structurally acceptable.

increase with time spent in Region C." *Union of Concerned Scientists Report, supra* at 4. The renewal period of a nuclear plant is its Region C, or wear-out phase. "As reactors approach or enter Region C [the wear-out phase] and become more vulnerable to failure, aging management programs monitor the condition of equipment and structures so as to effect repairs or replacements before minimum safety margins are compromised. Unfortunately, age-related degradation is being found too often by failures than by condition-monitoring activities." *Id.* at 20.

2.3.4 The Aging Management Program at Pilgrim only requires inspection of the drywell liner every ten years and primarily relies on visual examinations which cannot monitor for corrosion of inaccessible areas of the drywell

In Appendix A.2.1.17 of its application for license renewal, Entergy has described how it performs inservice inspections on the drywell (Inservice Inspection – Containment Inservice Inspection (CII) Program. The ISI Program is based on ASME Inspection Program B which has a ten year inspection schedule. Every ten years the program is updated to the latest ASME Section XI code edition and addendum approved in 10 CFR 50.55a. On July 1, 2005 PNPS entered the fourth ISI interval. The code edition and addenda used for the fourth interval is the 1998 Edition with 2000 Addenda.
This section says "The primary inspection method for the primary containment and its integral attachments is visual examination. Visual examinations are performed either directly or remotely with illumination and resolution suitable for the local environment to assess general conditions that may affect either the containment structural integrity or leak tightness of the pressure retaining equipment. The program includes augmented ultrasonic exams to measure thickness of the containment drywell structure."[12] It is not clear from the Application for License Renewal where and how often the ultra-sonic test measurements for drywell thickness are made. If the triggering mechanism for these measurements is visual evidence of corrosion, then this program will not detect

[12] The program consists of periodic volumetric, surface, and visual examination of components and their supports for assessment, signs of degradation, flaw evaluation, and corrective actions. (Application A.2.1.18 Inservice Inspection – Inservice Inspection (ISI) Program).

potentially serious corrosion in inaccessible areas, such as the concrete bed, until a serious problem arises.

In his work for Oyster Creek, Dr. Rudolf H. Hausler, President of Corro-Consulta has described the limited usefulness of visual inspection of these drywell areas. *In the Matter of American Energy Company, LLC* (Oyster Creek Nuclear Generating Station) Request for a Hearing and Petition to Intervene (November 14, 2005). In addition he highlighted a likely problem area for corrosion that would be inaccessible both to visual inspections and to UT inspections at the interface between the concrete at the bottom of the liner and the steel liner. He stated that this kind of three phase boundary (steel/concrete/water-air) is a well known site of corrosion. *Id.* No monitoring has been carried out in this region at Oyster Creek, and apparently no monitoring for corrosion of this likely problem area has been done at Pilgrim, even though water must have been present in the area to have caused the past corrosion. Because of the difficulty of inspecting these inaccessible areas of the drywell, either visually or by UT, the Aging Management Plan should require a root cause analysis any time water leakage into the drywell region has been found. The NRC staff acknowledged the importance of root cause analyses as part of the aging management of corrosion both in the January 31, 2006 teleconference, and in the March 23, 2006 teleconference.

2.4 Conclusion: The Aging Management Plan at Pilgrim should include regular UT measurements of all critical areas of the drywell liner and a root cause analysis of any drywell areas where water has been found before license renewal is granted

The Petitioners request that, should license renewal be granted, the UT measurements should be taken frequently enough over the 20 year extension to confirm that the actual corrosion measurement results are as projected. In addition, UT measurements should be greatly expanded into areas not previously inspected at all critical levels of the drywell liner, including the section of the liner that is submerged into the concrete floor. Multiple measurements should be made to determine "crevice corrosion" for the liner that is submerged into the concrete floor where water may have worked its way through cracks, pooled and corroded containment, as well as those areas identified by a root cause analysis that may be the cause of leakage, including the

refueling seal. Petitioners ask that the Applicant be required to submit the results to the United States Nuclear Regulatory Commission as publicly available documents as part of the license extension proceeding for the Petitioners' independent review and analysis. The Petitioners further request that the Applicant's new UT measurements of all critical areas shall concur with ASME standards governing the safety limitations of the drywell liner. The potentially dire consequences of corrosion and thinning of the drywell liner (which could include the buckling and collapse of the drywell and an inability to contain gases) make this thorough investigation indispensable.

Petitioners assert that the best way to assure compliance with NRC standards for public health and safety is to link license renewal to an aggressive Aging Management Program that meets these standards. Pilgrim does not currently have in place a program that will do so. The recommendations in LR-ISG-2006-01, *Plant-Specific Aging Management Program for Inaccessible Areas of Boiling Water Reactor Mark I Steel Containment Drywell Shell* should be immediately incorporated into Pilgrim's Aging Management Plan before a license extension is approved.

II. Environmental Contentions

Contention 3: The Environmental Report is inadequate because it ignores the true off-site radiological and economic consequences of a severe accident at Pilgrim in its Severe Accident Mitigation Alternatives (SAMA) analysis

3.0 Contention

The Environmental Report inadequately accounts for off-site health exposure and economic costs in its SAMA analysis of severe accidents. By using probabilistic modeling and incorrectly inputting certain parameters into the modeling software, Entergy has downplayed the consequences of a severe accident at Pilgrim and this has caused it to draw incorrect conclusions about the costs versus benefits of possible mitigation alternatives.

3.1 The Contention is within the Scope of these proceedings

Under 10 CFR §2.309, a petitioner is required to show that the issue raised in the contention is within the scope of the proceeding. The National Environmental Policy Act, NEPA, 42 USC § 4332, is the "basic charter for protection of the environment." 40 CFR § 1500.1(a). Its fundamental purpose is to "help public officials make decisions that are based on understanding of environmental consequences, and take decisions that protect, restore and enhance the environment." 40 CFR § 1500.1(c). The NRC regulations implementing NEPA for Nuclear Plant license renewals are in 10 CFR § 51(c) "Operating license renewal stage." In its application for license renewal of Pilgrim, Entergy was required under 10 CFR § 51 to provide an analysis of the impacts on the environment that will result if it is allowed to continue beyond the initial license. The primary method by which NEPA ensures that its mandate is met is the "action-forcing" requirement for preparation of an EIS. *Robertson v. Methow Valley,* 490 U.S. at 348-49 (1989). The environmental impacts that must be considered in an EIS include those which are "reasonably foreseeable" and have "catastrophic consequences, even if their probability of occurrence is low." 40 CFR §1502.22(b)(1). The fact that the likelihood

of an impact may not be easily quantifiable is not an excuse for failing to address it in an EIS. NRC regulations require that "to the extent that there are important qualitative considerations or factors that cannot be quantified, these considerations or factors will be discussed in qualitative terms." 10 CFR§51.71. The regulation governing licensing renewals requires the Applicant for renewal to submit an Environmental Report. 10 CFR 51.53(c)(1). The NRC then uses the ER to prepare an EIS or Environmental Assessment, although it has an independent obligation to "evaluate and be responsible for the reliability" of the information. 10 CFR §51.70.

In a petition for intervention, contentions that seek compliance with NEPA must be based on the applicant's Environmental Report (ER). 10 CFR§2.309(f)(2). Under 10 CFR §51 (c)(3)(ii) the plant is required to provide an ER that contains analyses of the environmental impacts of the proposed action, including the impacts of refurbishment activities, if any, associated with license renewal and the impacts of operation during the renewal term for those issues identified as Category 2 issues in Appendix B to subpart A of that part. Under 10 CFR §51(c)(ii)(L) "if the staff has not previously considered severe accident mitigation alternatives for the applicant's plant in an environmental impact statement or related supplement or in an environmental assessment, a consideration of alternatives to mitigate severe accidents must be provided." Severe Accidents are a Category 2 issue in Subpart B to Appendix A of section 51, which states "the probability weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to ground water, and societal and economic impacts from severe accidents are small for all plants. However, alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives." Contentions implicating Category 2 issues ordinarily are deemed to be within the scope of license renewal proceedings. *See Turkey Point supra* at 11-13. As Pilgrim did not consider mitigation alternatives for accidents in the environmental impact statement of its original licensing, this issue is within the scope of this proceeding.

3.2 The Issue Raised in the Contention is Material to these proceedings

10 CFR 2.309(f)(iv) requires that the Petitioner "Demonstrate that the issue raised in the contention is material to the findings the NRC must make to support the action that

is involved in the proceeding." In discussing the materiality requirement, the Atomic Safety and Licensing Board considering the license renewal for Millstone Nuclear Power Station stated "In order to be admissible, the regulations require that all contentions assert an issue of law or fact that is material to the outcome of a licensing proceeding; that is, the subject matter of the contention must impact the grant or denial of a pending license application. Where a contention alleges a deficiency or error in the application, the deficiency or error must have some independent health and safety significance." *In the Matter of Dominion Nuclear Connecticut, Inc.* (Millstone Nuclear Power Station, Units 2 and 3) Docket Nos. 50-336-LR, 50-423-LR ASLBP No. 04-824-01-LR July 28, 2004, p. 7. See Private Fuel Storage, L.L.C. (Independent Spent Fuel Storage Installation), LBP-98-7, 47 NRC 142, 179-80 (1998), aff'd in part, CLI-98-13, 48 NRC 26 (1998). The deficiency highlighted in this contention has enormous independent health and safety significance. By using probabilistic modeling and incorrect parameters in its SAMA analysis Entergy arrives at a result that downplays the likely consequences of a severe accident at PNPS, and thus incorrectly discounts possible mitigation alternatives. This could have enormous implications for public health and safety because a potentially cost effective mitigation alternative might not be considered that could prevent or reduce the impacts of that accident. Petitioners allege the Environmental Report's SAMA analysis is deficient and the deficiency could significantly impact health and safety.

3.3 There is a Substantial Basis for the Contention

The regulatory requirement that applicants for an operating license renewal perform a Severe Accident Mitigation Alternatives analysis is broad. 10 CFR § 51.53(c)(3)(ii)(L) states "If the staff has not previously considered severe accident mitigation alternatives for the applicant's plant in an environmental impact statement or related supplement or in an environmental assessment, a consideration of alternatives to mitigate severe accidents must be provided." Appendix B to Subpart A of this section describes the environmental effects of severe accidents due to license renewal. "The probability weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to ground water, and societal and economic impacts from severe accidents are small for all plants. However, alternatives to mitigate severe accidents must be

considered for all plants that have not considered such alternatives." The regulation acknowledges that the "probability weighted consequences" are small, and yet the requirement to consider mitigation remains. The regulation does not mandate how these mitigation alternatives should be evaluated – but the language in Appendix B makes it clear that the applicant should consider alternatives that could mitigate the consequences listed, including "atmospheric releases, fallout onto open bodies of water, releases to ground water, and societal and economic impacts."

In its SAMA analysis, the Applicant did not fully consider the above listed consequences. Instead, the likely impacts of a severe accident have been drastically minimized by using probabilistic modeling which makes the costs of all severe accidents appear negligible. In addition, Entergy has used incorrect input parameters, including meteorological, emergency response, and economic data, into a software model of limited scope. In this contention Petitioners will address the input parameters used by Entergy in its SAMA analysis. However the overarching defect in the Applicant's SAMA analysis is that it looked at severe accident ***risks***, rather than severe accident ***mitigation alternatives***, as required by the regulations. As described below, any time an Applicant multiplies an accident consequence by an extremely low probability number, the consequences will appear minute. The regulations require a broad assessment of mitigation alternatives, not an easy dismissal by "probability weighting."

3.3.1 Probabilistic modeling can underestimate the true consequences of a severe accident

The regulatory requirement that nuclear plants perform a SAMA analysis states: "The probability weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to ground water, and societal and economic impacts from severe accidents are small for all plants. However, alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives." Appendix B to Subpart A of 10 CFR §51.53. In other words, ***even though*** the probability of a severe accident is so low that the impacts can be considered small, all plants must still consider alternatives to mitigate the consequences of those accidents.

In its ER, Entergy estimated the severe accident risk by using the Probabilistic Safety Analysis (PSA) Model and a Level 3 model developed by the MACCS2 code. Using this method, the application states that "Risk is defined as the product of consequence and frequency of accidental release." Application ER E.1.5.1. In using the PSA Model to estimate risk, Pilgrim was most likely following industry practices. However, it was not following the dictates of the license renewal regulation. As stated above, the regulation acknowledges up front that the probability weighted risk is small but requires alternatives to be looked at anyway.

In the license renewal proceeding for Turkey Point, the board used the following interpretation of the regulations to dismiss the Petitioners concerns about particular severe accidents. It stated, ". . . the commission's environmental regulations in 10 C.F.R. Part 51 do not require probabilistic risk assessments. Section 51.53(c) lists the information the Applicant must include in its environmental report, and a probabilistic risk analysis of multiple failures is not specified. Likewise sections 51.71(d) and 51.95(c) set forth the requirements the agency must follow in preparing the draft and final SEIS for the Turkey Point license renewal, and nowhere do those provisions require the preparation of a probabilistic risk analysis of multiple failures." *Turkey Point,* supra at 23-24. It went on to say, ". . . section 51.53(c) does not require the Applicant broadly to consider severe accident risks. Rather, it only requires the Applicant to consider "severe accident mitigation alternatives" (SAMA). 10 C.F.R. § 51.53(c)(3)(ii)(L). *Id.* at 26. While in that instance the licensing board used this argument to reject the Petitioners contention related to Emergency Preparedness, the board's reading of the regulatory requirement is also instructive here. It would make no sense for the NRC to require Severe Accident Mitigation Analysis if an Applicant could simply multiply all consequences of an accident by extremely low probability and thus reject all possible mitigation as too costly.

It is widely recognized that probabilistic modeling can underestimate the deaths, injuries, and economic impact likely from a severe accident. By multiplying high consequence values with low probability numbers, the consequence figures appear far less startling. For example a release that would cause 100,000 cancer fatalities would only appear to cause 1 cancer fatality per year if the associated probability of the release

were 1/100,000 per year. This issue was central to a New York case, *Indian Point Special Proceeding*, US Nuclear Regulatory Commission, Atomic Safety and Licensing Board, Recommendations to the Commission, October 24, 1983, p. 107. Before the proceeding, the NRC ruled that all testimony on accident consequences must also contain a discussion of accident probabilities. In its decision, the three-judge ASLB panel concluded that "the Commission should not ignore the potential consequences of severe-consequence accidents by always multiplying those consequences by low probability values."

In addition, in his report on the likely consequences of an accident at the Indian Point Nuclear Plant, Dr. Edwin S. Lyman stresses that intentional acts represent a class of accidents that should not be considered using probabilistic modeling. "Accident probabilities are not relevant for scenarios that are intentionally caused by sabotage. Severe releases resulting from the simultaneous failure of multiple safety systems, while very unlikely if left up to chance, are precisely the outcomes sought by terrorists seeking to maximize the impact of their attack. Thus the most unlikely accident sequences may well be the most likely sabotage sequences." Edwin S. Lyman, PhD, *Chernobyl on the Hudson? The Health and Economic Impacts of a Terrorist Attack at the Indian Point Nuclear Plant*, Union of Concerned Scientists, p. 16 (September, 2004).

3.3.2 Entergy used an outdated version of the MACCS2 Code and MACCS2 User Guide, and ignored warnings about the limitations of this model

In addition to minimizing accident consequences by using the PSA, Entergy may also have minimized consequences by using incorrect input parameters for the computer consequence model. Although the regulations do not stipulate how the consideration of mitigation alternatives must be carried out, NUREG – 1437 discusses the CRAC2 Code and the MACCS2 Code. The MACCS2 ("MELCOR Accident Consequence Code System"), was developed by Sandia National Laboratories in 1997, and is currently the state-of-the-art consequence code employed by both NRC and DOE in conducting dose assessments of radiological releases to the atmosphere. Since its release, there have been widespread criticisms about the code's shortcomings and limitations. David I. Chanin, *The Development of MACCS2: Lessons Learned*, Energy Facilities Contractor Operating

Group Safety Analysis Working Group, Annual Workshop, April 29–May 5, 2005, Santa Fe, NM. In 2004, the Department of Energy conducted a Software Gap Analysis on the MACCS2 Code to assess its weaknesses and make recommendations for improvement. The resulting report gave several warnings about the limitations of the software. It concluded that "software concerns and issues can be avoided by understanding MACCS2 limitations and capabilities. The software can be applied for modeling those types of scenarios where precedents exist, and there is confidence that alternative analysis or experimental data would adequately confirm the code predictions." [13] The report concluded that "When the code is run for the intended applications as detailed in the code guidance document, MACCS2 *Computer Code Application Guidance for Documented Safety Analysis*, (DOE 2004) and also utilizing information from documentation available from SNL and other sources (Table 1-3), it is judged that it will meet the intended function. . . . Confidence in MACCS2 to meet its intended function is expected to increase with the release of Version 1.13. The software developer has indicated that Version 1.13 corrects known errors in Version 1.12."

Entergy refers in its SAMA analysis to an older User Guide for MACCS2, the Code Manual for MACCS2: Volume 1, User's Guide, SAND97-0594, which was written in 1997. Chanin, D.I., and M.L. Young, Code Manual for MACCS2:Volume 1, User's

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[13] Defense Nuclear Facilities Safety Board Recommendation 2002-1, Software Quality Assurance Improvement Plan Commitment 4.2.1.3: Software Quality Assurance Improvement Plan: MACCS2 Gap Analysis. DOE-EH-4.2.1.3-MACCS2-Gap Analysis (May, 2004). Specifically, the report noted four broad technical issues:

- Phenomenology: The fire plume model may be non-conservative. It is recommended that the current treatment be carefully used in MACCS2, taking into account building wake effects, sensible energy and spatial dependence of the source term and combustible loading. As a long-term consideration, area source models, such as that proposed by Mills (1987) for pool fire analysis could be made available as a user-specified option in MACCS2. (This topic was addressed in Section 2.3).
- Coding Errors: Software defects encountered exercising (1) multiple plume segments and (2) the emergency response model, should be addressed immediately by the code developers. A maintenance version with the major defects corrected should be made available to RSICC. A similar strategy was used for the predecessor software to MACCS2, MACCS, in creating Version 1.5.11.1. In the interim, DOE user guidance should be applied to avoid these conditions in MACCS2 (DOE, 2004).
- End User Quality Assurance Problem: Dose conversion factors are user-specified data file input options in MACCS2. For example, non-conservative inputs for plutonium radionuclides can be unintentionally selected by users. It is recommended that user instructions (user's manual) address this potential pitfall in running MACCS2. In addition, enhanced training on the options in MACCS2 for dose factor file selection is recommended. (This topic was addressed in Section 2.3).
- Poor Documentation: Documentation for MACCS2 should be revised as part of the new software baseline. In particular, the user's guide should provide sample input files for various types of "standard" problem types encountered in both reactor and non-reactor nuclear facility safety analysis. (This topic was addressed in Section 2.3).

Guide, SAND97-0594 Sandia National Laboratories, Albuquerque, NM, (1997). The newer (2004) guide highlights potential problems and prescribes the circumstances in which the model can be used, but was not listed with the other references by the Applicant. Some of the precautions in the 2004 guide are in a list of "Regimes of Applicability" for the MACCS2 Code. [14] However, even the older (1997) guide warns of the limitations of the software. In section 6, "Restrictions or Limitations", it states, "The atmospheric model included in the code does not model the impact of terrain effects on atmospheric dispersion. The code also does not model dispersion close to the source (less than 100 meters from the source) or long range dispersion. The economic model included in the code models only the economic cost of mitigative actions." In addition, as noted in the Gap Analysis by DOE, the User has an enormous ability to affect the output from the code by manipulating the inputs and choosing parameters. Section 6.10 of the 1997 User Guide, Generation of Consequence Distributions, states "Under the

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[14] MACCS2 Guidance Report June 2004 Final Report, page 3-8:3.2 Phenomenological Regimes of Applicability:
The MACCS2 class of atmospheric dispersion codes is based on the Gaussian model of dispersion. As such, these types of computer model are best suited for specific types of conditions. The chief phenomenological regimes that should be considered before applying MACCS2 include:
• Temporal regime – The use of these codes is best suited for "short" duration plumes, ranging from approximately several minutes to several days.
• Spatial regime - The class of code also does not model dispersion close to the source (less than 100 meters from the source), especially where the influence of structures or other obstacles is still significant. Dispersion influenced by several, collocated facilities, within several hundred meters of each other should be modeled with care. Similarly, the MACCS2 class of codes should be applied with caution at distances greater than ten to fifteen miles, especially if meteorological conditions are likely to be different from those at the source of the release. Long-range projections of dose conditions are better calculated with mesoscale, regional models that are able to account for multiple weather observations. Nevertheless, some applications may require fifty-mile or greater radius analysis to meet requirements, e.g. Environmental Impact Statements (EISs) or Probabilistic Safety Assessments (PSAs).
• Terrain variability – Gaussian models are inherently flat-earth models, and perform best over regions of transport where there is minimal variation in terrain. Because of this, there is inherent conservatism (and simplicity) if the environs have a significant nearby buildings, tall vegetation, or grade variations not taken into account in the dispersion parameterization.
• Energetic releases – MACCS2 does not account for momentum-driven releases or those originating from detonation type events without appreciable post-processing of boundary and initial conditions. Using the latter approach, Steele (1998) has demonstrated a MACCS2-based, segmented methodology for a detonation source term that was found to compare well with observations.
• Thermal buoyancy - In plumes arising from fire-related source terms, the user should exercise caution with the models such as MACCS2 that use the Briggs algorithm. The Briggs approach for accounting for sensible energy in a plume is valid for "open-field" releases (not impacted by buildings and other obstacles), or if used in combination with building wake effects. Appendix C provides a limited sensitivity study of the effects of buoyancy and building wake effects on plume dispersion.
• Dose conversion factor applicability – The user should ensure that the dose conversion factors used in MACCS2 are applicable to the radionuclides in the source term and the physicochemical characteristics.

control of parameters supplied by the user on the EARLY and CHRONC input files, the EARLY and CHRONC modules can calculate a variety of different consequence measures to portray the impact of a facility accident on the surrounding region. ***The user has total control over the results that will be produced.***" (emphasis added) Undoubtedly, this is why one of the DOE report's recommendations is better training for the users of the MACCS2 Code.

Currently, the complete inputs to the MACCS2 for the license renewal of Pilgrim are not publicly available, and are not included in the Applicant's Environmental Report. Without knowing what parameters were chosen by the Applicant, it is not possible to fully evaluate the correctness of the conclusions about Severe Accident Mitigation Alternatives. However, from what is included in the ER, Petitioners have been able to piece together some possible reasons that Entergy's described consequences of a severe accident at Pilgrim look so small.

3.3.3 Entergy used incorrect input data to analyze severe accident consequences

Neither the MACCS2 model used to analyze consequence nor the input data provided by the applicant provide an accurate assessment of the off-site dose and economic consequences of a severe accident. As discussed above, there are limitations inherent in the software which can result in an incorrect evaluation of actual plume dispersion and which by design omit the majority of economic costs. In addition to these built-in limitations, Entergy's inputs to the code, including meteorological data, demographics, emergency response, and regional economic data, were incomplete, incorrect or out of date. These inaccuracies result in incorrect conclusions drawn about accident consequences and minimize the likely risks of a severe accident.

3.3.3.1 Meteorological Data

Radiological consequences from a severe accident are strongly dependent on meteorological conditions and these conditions are complex and particular to each site. The modeling tool used by the applicant and the applicant's input to that model fail to properly characterize weather conditions. The MACCS2 code utilizes a standard

straight-line Gaussian plume model to estimate the atmospheric dispersion of a point release of radionuclides. The ER states that the shape of the Gaussian plume is determined by the wind speed, the release duration, the atmospheric stability, class and the height of the mixing layer at the time of the release. Application ER, E.1.5.2.6 p. E-1-63 to E-1-64.

In his report "Chernobyl on the Hudson?," Dr. Edwin S. Lyman discusses the limitations of the MACCS2 model. "Like most radiological consequence codes in common use, MACCS2 has a number of limitations. First of all, because it incorporates a Gaussian plume model, the speed and direction of the plume are determined by the initial wind speed and direction at the time of release, and cannot change in response to changing atmospheric conditions (either in time or in space). Consequently, the code becomes less reliable when predicting dispersion patterns over long distances and long time periods, given the increasing likelihood of wind shifts. Also, the Gaussian plume model does not take into account terrain effects, which can have a highly complex impact on wind field patterns and plume dispersion. And finally, MACCS2 cannot be used for estimating dispersion less than 100 meters (0.06 miles) from the source." *Chernobyl on the Hudson? supra* at 27.

A potentially larger problem with the model which is specific to Pilgrim is that winds along the coast of Massachusetts are heavily affected by the well-documented sea breeze phenomenon. The sea breeze effect is especially important because dose is a product of concentration and episode duration; and the duration is a function of the relative sea breeze strength. In 1988, the Massachusetts Department of Public Health contracted with Dr. J.D. Spengler and Dr. G.J. Keeler of Harvard University to study the wind patterns around Pilgrim Station. J.D. Spengler and Dr. G.J. Keeler, *Feasibility of Exposure Assessment for the Pilgrim Nuclear Power Plant*, Prepared for Massachusetts Department of Public Health, May 12, 1988. Their report describes in detail the sea breeze phenomena that would be expected at this site.[15] The topography of a coastal

[15] The uneven heating rates of land and water is responsible for the well known mesoscale coastal winds known as sea and land breezes. During the day, the land heats more quickly than the adjacent water, and the intensive heating of the air above the land produces a shallow thermal low. The air over the water remains cooler that the air over the land and hence a shallow thermal high exists above the water. The overall effect of this pressure distribution is a surface breeze that blows from the sea. Since the strongest gradients of temperature difference between the land and water usually occurs in the afternoon, sea breezes

environment also plays an important role in the sea breeze circulation. When cool, dense, stable marine air encounters a hill or mountain, the heavy air tends to flow around them rather than over them. This can alter the flow pattern expected from a typical sea breeze along a flat coastline. These considerations are of great importance in estimating area-wide contaminant exposures in coastal environments. *Id.* at 6. "The meteorological sites available provide limited ability to fully characterize or model the sea breeze circulation in the vicinity of the Pilgrim I Nuclear Power Plant." *Id.* at 1.

The Applicant's meteorological input data to the code came from two sources. To determine wind speed, wind direction, atmospheric stability, and mixing heights, the applicant used a weather tower on the reactor's site. To determine precipitation data, the applicant used the Plymouth Airport, which is about five miles inland from the site. Application ER, E.1.5.2.6. However, to capture what would happen once a plume is released from the site – the swirling complexity and wind shifts - and what would happen in localized pockets of fog, would require measurements from multiple sites in the field. To better characterize meteorological conditions, Entergy should collect and use the following data – data which is critical in any event for planning and directing an emergency response to a severe accident.

3.3.3.1. a Wind speed

Accurately characterizing wind speed is critical to estimating concentration. The data obtained at the Pilgrim location will not accurately represent plume transport wind speed. Because: 1) air flow over land is modified by topography and is retarded by

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are strongest at this time. At night the land cools more quickly than the water. Air above the land becomes cooler that the air above the water producing a pressure differential. With the higher pressure now over the land and the wind reverses itself and becomes a land breeze, flow from the land to the sea. Temperature gradients between land and water at night are usually much smaller than during the day, and hence the land breeze tends to be weaker. Since sea breezes best develop when large temperature differences exist between land and water, their importance would be greatest in spring and summers. During the summer, a sea breeze usually occurs in the mid-morning after the land has been heated by the sun. By early afternoon the breeze has increased in strength and depth. In the late afternoon the cooler ocean air may extend inland for more than 10 miles and extend vertically up to 1000 feet. The leading edge of the sea breeze is referred to as the sea breeze front. As this front moves inland, a rapid drop in temperature occurs directly behind. Temperature drops of 5 degrees C or more can occur during the onset of the sea breeze. Along the Atlantic Coast, the passage of a sea breeze front is accompanied by a rapid wind shift, usually from west to east. If there is a sharp temperature gradient across the frontal boundary, the warmer air will converge and rise, typically marked by line of cumulus clouds. Along the sea breeze frontal boundary air can rise to elevations where it becomes part of the return flow. The return flow can rapidly mix the air down to the surface far behind the front.

surface friction; 2) convective overturn or stratification of air can modify vertical wind speed profiles; and 3) sea breeze will decrease wind speed as they move over land. Since there are no appropriately located inland meteorological monitoring sites around the Pilgrim location, there is no way to precisely adjust wind speed information for off-site transport conditions.

3.3.3.1. b Wind Direction

Wind direction will change with height above the ground and will be influenced by terrain features. The coriolis effect will cause a clockwise turning of the wind direction as the sea breeze develops over the course of the day. This effect is reflected in the coastal wind sensor, but the effect of surface friction and surface features are not. As a result wind blowing inland will experience the frictional effects of the surface which decreases speed and changes direction.

3.3.3.1. c Dispersion

Turbulence in the atmosphere causes a plume to spread and hence dilute. Turbulence is generated by surface friction and thermal instabilities. The over-water turbulent conditions can be estimated from meteorological measurements at the Pilgrim site. However with onshore winds the tower measurements do not reflect the effects of the overland conditions. The wind is likely to be slightly stable as it approaches land and Pilgrim's meteorological tower. As air flows over a heated surface thermally generated turbulence is induced. Under sea breeze conditions the turbulence structure of the atmosphere will not be accurately determined by the meteorological sensors at the coastal site. Dispersion is also affected by precipitation. Like wind flow, precipitation is highly complex – for example, fog patches vary along coastal locations and also in the interior affected by ponds and bogs. On a drizzly, foggy day with a low inversion layer and constant easterly winds there would potentially be less dispersion than a clear day with strong winds and a sea breeze. Fog patches and precipitation can be highly localized therefore precipitation data from one location at Plymouth Airport located 5 or so miles inland are inadequate.

To obtain an accurate analysis it is necessary to install continuous recording meteorological instruments along the coast and at additional inland sites in the communities likely to be impacted by Pilgrim, for example the 7 towns identified by

Spengler and Keeler (see Exhibit C). The parameters measured should include wind speed and direction, temperature, dew point, and solar insulation. This would allow an analysis which could more adequately analyze the penetration of the sea breeze front and better characterize the spatial variation of the wind flow.

The NRC has acknowledged that more meteorological data may be required. In Regulatory Guide 1.194, this subject is discussed as follows: "The NRC staff considers 5 years of

hourly observations to be representative of long-term trends at most sites. With sufficient justification of its representativeness, the minimum meteorological data set is one complete year (including all four seasons) of hourly observations" (NRC, 2003). Despite the fact that several site specific reports (see Exhibit C) have been prepared for Pilgrim that show one year of observations gathered from one site will not satisfy this "representativeness" requirement, the Applicant has used only one year's worth of observations, gathered from only one location. The inputs into the MACCS2 Code are inadequate. In Exhibit E Petitioners describe an improved scheme for meteorological monitoring. This improved monitoring will not just provide better inputs for this kind of Severe Accident Modeling, but it is also a necessary tool for Emergency Planning.

3.3.3.2 Demographic Data

Because the MACCS2 Code utilizes a straight-line Gaussian plume model to estimate the atmospheric dispersion of a release, the demographic input data provided by the applicant is a spatial distribution arranged by geographic sectors, or "spatial elements." Application ER, Appendix E.1-61, Table E.1-13. The total population within a 50-mile radius of PNPS was estimated by Entergy for the year 2032 by combining total resident population projections with transient population data from Massachusetts and Rhode Island. Table E. 1-13 shows the estimated population distribution. Application ER Appendix E.1-61. This population table is broken down into directional sectors, as well as distance from the nuclear plant. However, because of the unpredictability and complexity of the winds at the Pilgrim site, the more realistic approach would be to use a more inclusive population within rings around the plant, when calculating off-site dose costs.

3.3.3.3 Emergency Response Data

The assumptions in the models used by the applicant and the input data put into those models do not provide credible conclusions regarding emergency response outcomes in a severe accident. Nor is there reasonable assurance that the assumptions used by FEMA in this area have any credibility.[16] The MACCS2 emergency planning model requires the user to input the time when notification is given to emergency response officials to initiate protective actions for the surrounding population; the time at which evacuation begins after notification is received; and the effective evacuation speed. However, the model assumes that the population is out of danger once crossing the 10-mile boundary. This will not be true in a severe accident such as a core melt and/or a spent fuel pool accident that leads to a zirconium fire. *Safety and Security of Commercial Spent Nuclear Fuel Storage Public Report,* National Academy of Sciences, 3 (April, 2005).

In addition, the model does not consider those who cannot evacuate and must shelter. Protective actions involve both evacuation and sheltering. Under some circumstances evacuation will not be possible for all or a portion of the affected population. The elderly often require transportation assistance because they are infirm, cannot drive themselves or have only one car per household that may not be available in an emergency.

The applicant's evacuation time input data is from, *Pilgrim Station Evacuation Time Estimates and Traffic Management Plan Update, Revision 5,* (November 1998). However later data is available. KLD prepared a later report for Entergy, *Pilgrim Nuclear Power Station Development of Evacuation Time Estimates, KLD TR-382, Revision 6,* (October 2004). The newer KLD study relies on newer census data and newer roadway geometric data. The most recent data available should be used as source material to get the most accurate estimates.[17]

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[16] . The Senate Homeland Security and Governmental Affairs Committee issued [April 27, 2006] an 800-plus-page report, "Hurricane Katrina: A Nation Still Unprepared." Sen. Susan Collins, R-Maine, Chair of the Committee summarized the report in a written statement that, "We have concluded that FEMA is in shambles and beyond repair, and that it should be abolished."

Many of the assumptions and study estimates in the applicant's source, *Pilgrim Station Evacuation Time Estimates and Traffic Management Plan Update, Revision 5,* (November 1998) are faulty. For example, voluntary evacuation from within the EPZ was estimated to be 50% within a 2-5 mile ring around the reactor, excluding the "key-hole;" and 25% in the annular ring between the 5-mile boundary of the circle and the 10-mile EPZ boundary.[18] Shadow evacuation was not considered.[19] Special Events, such as the July 4th celebration, were not considered. Evacuation time estimates for the EPZ was performed for, "Off-season mid-week, mid-day in good weather; and Summer mid-week, mid-day, good weather." Using the above false assumptions, the study describes unrealistically low evacuation time estimates. Clearly there is no guarantee that an accident will not occur on holidays, during the commuter rush hour, on summer week-ends, or in bad weather. Emergency planning and a severe accident analysis should assume the worst case scenario.

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[17] The 2004 KLD Report compares the 1998 previous ETE Study to the 2004 Current ETE Study, Table 1-1. ETE Study Comparisons, p 1-9. Significant differences include, for example:

Topic	1998 ETE Study	2004 ETE Study
Resident Population	1990 Census	2000 Census, extrapolated to 2005
Employee Population	Growth in state employment between 1990 and 1996 used to project 1997 employment Estimated employees for each town that lived in EPZ, number walk to work, number work at home	Growth in state employment between 1990-2000 to extrapolate to 2005. Employment journey to work data (State 2001 data files) identified portion of employees who commute into EPZ relative to total number. In addition data surveys were sent to major employers.
Transient Population		More detailed analysis day-trippers carried out
Roadway Geometric Data	Road capacities based 1994 HCM	Road capacities based on 2000HCM

[18] The Town of Duxbury at Annual Meeting, 2006, recognized that many more citizens would be at risk than those within 2/5 miles and they would voluntarily evacuate, along with those outside the 10-miles; hence the Town Meeting voted to oppose the 2/5 miles planning policy.

[19] Three Mile Island provides the best, and perhaps only, realistic example. There, the Pennsylvania Governor issued an evacuation advisory (note, it was not an order). It was expected to have precipitated the flight of only 3,400 people (pregnant women and pre-school children within five miles of the plant); instead, a total of 144,000 people (a government figure) evacuated the surrounding region. Donald J. Zeigler, Ph.D. found the same in a telephone survey of households near Shoreham and later in households near Indian Point. *Evacuation Behavior In Response To Nuclear Power Plant Accidents*, by Donald Zeigler and James Johnson, Jr., The Professional Geographer (May, 1984).

3.3.3.3. a Evacuation Delay time

The Environmental Report states "The elapsed time between siren alert and the beginning of the evacuation is 40 minutes. A sensitivity case that assumes 2 hours for evacuees to begin evacuation was considered in this study to evaluate consequence sensitivities due to uncertainties in delay time." Application ER Appendix E.1.5.2.7, p. E-1-64. In other words, the assumption is that the longest likely delay before residents begin to evacuate is 2 hours. This assumption is incorrect for the simple reason that notice of the evacuation could take longer than 2 hours to reach people. The sirens that are in place cannot be heard by residents inside some buildings and houses, when the windows are closed, when air conditioners are on, in bad weather, or if the dwellings are set back from a main road. They also cannot be heard inside vehicles. Citizens have complained to Entergy about the inadequacies of the early warning sirens. It is more likely that notification will result from word-of-mouth, adding to delay. If, for example, the accident occurs at 1:00AM, it would be more than 5-6 hours before the community had awakened and word spread.

The peak population in the EPZ approximates 100,000 who are spread over approximately 150 square miles and engaged in a variety of activities. Hence it must be anticipated that some time will elapse between transmission and receipt of information advising people of the accident. The amount of elapsed time will vary from one individual to the next depending where that person is (at home, at the beach, sailing or in motor boats, fishing, out-of-home entertainment center); what the person is doing (working, shopping at a regional mall); time of day, families may be united in the evenings, but dispersed in the day; week-day versus week-end and holidays. Some may be outside the EPZ at the time the emergency is declared. These people may be commuters, shoppers who reside within the EPZ and who will return to join the other household members upon notification of an emergency. Use of a 2 hour delay time in the sensitivity case is overly optimistic.

3.3.3.3. b Evacuation Speed

The Environmental Report states "The worst case for Pilgrim is during the winter, under adverse weather conditions, since snow removal can add up to an hour and a half to

evacuation time. The radius of the Emergency Planning Zone is 10 miles. Assuming that the net movement of the entire population is 10 miles, the time required for evacuation ranges from 3 hours 35 minutes to 6 hours 30 minutes, and the average speed in clear weather to 1.54 miles/hour under adverse weather conditions. The average evacuation speed is 2.17 miles/hour, or 0.97 meter/second." And "A sensitivity case that assumes a lower evacuation speed of 0.69 meter/second was considered in this study to evaluate consequence uncertainties in evacuation speed." Application ER, E.1.5.2.7.

However, to arrive at this number, the applicant falsely assumes that in a severe accident harmful levels of radiation (and thus evacuation) will not extend beyond 10 miles. The Sandia National Laboratory CRAC-2 core melt consequence analysis for Pilgrim conservatively stated that the 1st year peak fatal radius was 20 miles and the 1st year peak injury radius was 65 miles. *Calculation of Reactor Accident Consequences, U.S. Nuclear Power Plants (CRAC-2),* Sandia National Laboratory (1982). The National Academy of Sciences has stated that a spent fuel pool accident that led to zirconium cladding fires "... would create thermal plumes that could potentially transport radioactive aerosols hundreds of miles downwind under appropriate atmospheric conditions" The Safety and Security of Commercial Spent Nuclear Fuel Storage Public Report, National Academy of Sciences, April 2005, p.50. Therefore, in a severe accident, evacuations will have to go well beyond 10 miles to protect public health and safety.

The assumption that snow removal can add up to an hour and a half to evacuation time is also optimistic. It assumes that workers will be available to plow and does not account for the likely event that they will evacuate with their families. And although July 4th holiday traffic could easily slow evacuations more than an hour and one-half, KLD did not analyze "special events" in their traffic estimates. Summer week-end traffic was also ignored despite the fact that Pilgrim is located in a popular summer resort area due to the many beaches, forests and historic sites. The route to and from Cape Cod passes almost directly past the nuclear plant such that traffic getting to and departing from the Cape travels over the same routes that are designated in a nuclear evacuation.

Shadow evacuation is ignored. Studies of human behavior following Three Mile Island (TMI) were described in a study published in *Evacuation Behavior In Response To Nuclear Power Plant Accidents*, Donald Ziegler and James Johnson, Jr., The Professional

Geographer, (May, 1984). At TMI a limited evacuation advisory of pregnant women and pre-school children within 5 miles of the reactor was recommended by the Governor; that number would have resulted in 3,400 evacuees. Instead up to 200,000 people actually evacuated, approximately 39% within 15 miles of the reactor. The "shadow" evacuation is not expected to diminish until approximately 25 miles out from the reactor. The study found that in addition to the high rate of voluntary evacuation, those evacuees tended to travel greater distances than observed in other kinds of disasters. The TMI study evidenced that the median distance traveled by evacuees was 85 miles. Professor Zeigler issued a later report for Long Island in December 2001. He reported on a telephone survey asking what the response would be if an accident occurred at Shoreham Station. He concluded if emergency planners assume that only those people who are told to evacuate will actually evacuate, they will expect 2,700 families to be on the road; instead, they will have 289,000 families from all over Long Island.

Extrapolating from these studies and looking at population projections in towns outside the Pilgrim EPZ, but along the major evacuation routes, makes it obvious that the roads upstream will be filled by panicked residents once word of the accident gets out. This could result in those near the core being trapped and their departure very significantly delayed.[20]

3.3.3.4 Economic Data

One of the cited criticisms of the MACCS2 Code is that "the economic model included in the code models only the economic cost of mitigative actions."[21] The MACCS2 model analysis of economic costs include the cost of decontamination, the cost of condemnation of property that can not be decontaminated to a specified level, and a lump sum compensation payment to all members of the public who are forced to relocate either

[20] For example, the route for Duxbury and Marshfield to Braintree High School Reception Center requires passing through the towns of Pembroke, Hanover, Norwell, Hingham, Weymouth and Braintree. The populations in the towns that feed onto Route 3 can be expected to evacuate also – the shadow evacuation. Route 3 was completed in 1963. It was designed to carry 76,000 cars daily but now handles about 140,000 on the stretch en route to Braintree High School. A widening project would add a third lane from Weymouth to Duxbury, if ever begun and completed 2012-2032; however with population projections from 2010 forward – the area really will not be better off. (Patriot Ledger March 7, 2005).

[21] 1997 MACCS2 User Guide.

temporarily or permanently as a result of the accident. These would include the costs associated with the emergency phase (*i.e.*, evacuation and short-term relocation), costs associated with the intermediate phase (*i.e.*, per-diem costs for relocation for the duration of the intermediate phase), and decontamination or interdiction for the longer term. (1997 User Guide, section 7) Nowhere in the assessment of the economic costs of a severe accident does the model account for the loss of economic activity in Plymouth County. The valuations include only the assessed value of the property, ignoring business value. The fact that the building is an on-going business with inventory, equipment, and income generation capability is not taken into account.

The tourism sector alone is important for the Commonwealth, Southeastern Massachusetts, and the host community, Plymouth, see Exhibit D. For example a report prepared for the Commonwealth, stated that nearly $ 11.2 billion is spent yearly on transportation, lodging, food, entertainment and recreation and incidentals. *The Economic Impact of Travel on Massachusetts Counties, 2003.* A Study Prepared for the Massachusetts Office of Travel and Tourism by the Research Department of the Travel Industry Association of America, Washington, D.C.(January, 2005). In a severe accident travel would be severely impacted in at least four Massachusetts counties –Plymouth, Barnstable, Dukes and Nantucket. The reason for this is that in order to travel to Cape Cod and the Islands it is necessary to go through Plymouth County. Additionally winds often blow toward the Cape and Islands. Travel expenditures for these counties in 2003 were: Plymouth County, $353.14 million; Barnstable County, $684.27 million; Dukes County, $91.86 million; Nantucket County, $139.93 million. *Id.* These figures exclude other travel impacts such as payroll, state tax receipts and local tax receipts.

Plimoth Plantation, the Mayflower, Plymouth Rock, and countless historical sites are within 10 miles of Pilgrim and attract visitors from around the world. Plimoth Plantation alone, which is less than five miles from the plant, brings in almost $10 million per year.[22] Even if cleanup and decomtamination of these sites were possible it is

[22] In 2005, the museum had about 345,000 visitors from all 50 U.S. states, as well as from around the world. Its annual income in 2005 from all sources (admissions revenue, retail sales, donations, grants, membership dues, etc) was about $9.5 million. Plimoth Plantation employs about 225 people. Roughly 50% of our staff reside in the Town of Plymouth, and about 75% reside in Plymouth County. *Personal communication,* Ivan Lipton ~ Chief Operating Officer, Plimoth Plantation

unlikely that this tourism would ever recover fully after a severe accident. Yet there is no economic analysis in the Environmental Report's SAMAs which accounts for the destruction of this region's economy as a major tourist, and historical and recreational area. By not counting these as costs of a severe accident, the Applicant might mistakenly disregard a mitigation alternative as being too expensive.

Dr. Edwin Lyman performed a MACCS2 analysis for Indian Point to assess what the costs of a severe accident at that plant would be. He more realistically concluded that in a severe accident there would be, "damages from hundreds of billions to trillions of dollars, and the permanent displacement of millions of individuals." *Chernobyl on the Hudson, supra* at 54. In his analysis he used only the MACCS2 economic cost parameters, not the actual economic costs of a severe accident in the region, which Petitioners contend should include loss of economic infrastructure and tourism. While one reason for his high consequence figure is that New York City is within the 50 mile EPZ of Indian Point, the results would not be so different in this case. Providence and Boston are both within 50 miles of a severe accident at PNPS should one occur. These cities are the most significant cities in New England - home of our nations' major Universities, hospitals, historic sites, investment firms, and are New England's economic hubs.

3.3.4 The faulty SAMA analysis used by Entergy in the Environmental Report caused it to wrongly dismiss mitigation alternatives such as adding a filter to the Direct Torus Vent

The purpose of a SAMA review is to ensure that any plant changes that have a potential for significantly improving severe accident safety performance are identified and addressed. *Duke Energy Corp., supra* at 5. For its SAMA analysis, the Pilgrim Environmental Report explains that, "A cost benefit analysis was performed on each of the remaining SAMA candidates. If the implementation cost of a SAMA candidate was determined to be greater than the potential benefit (i.e. there was a negative net value) the SAMA candidate was considered not to be cost beneficial and was not retained as a

potential enhancement. . . "The benefit of implementing a SAMA candidate was estimated in terms of averted consequences."[23] One example of how a poorly performed SAMA analysis can lead to erroneous conclusions is the ER's look at the costs and benefits of installing a direct torus vent filter at Pilgrim.

The Direct Torus Vent System (DTVS) is a method to relieve the high pressure which is generated during a severe accident. In 1986, Harold Denton, then the NRC's top safety official, told an industry trade group that the "Mark I containment, especially being smaller with lower design pressure, in spite of the suppression pool, if you look at the WASH 1400 safety study, you'll find something like a 90% probability of that containment failing." *Hazards of Boiling Water Reactors in the United States,* Paul Gunter, Nuclear Information Resource Service, Washington, D.C. (March 1996). In order to protect the Mark I containment from a total rupture it was determined necessary to vent a high pressure buildup. As a result, an industry workgroup designed and installed the "Direct Torus Vent System" at all Mark I reactors, including Pilgrim. Operated from the control room, the vent is a reinforced pipe installed in the torus and designed to release radioactive high pressure steam generated in a severe accident by allowing the unfiltered release directly to the atmosphere through the 300 foot vent stack. Use of the vent discharges steam and radioactive material directly to the atmosphere bypassing the standby gas treatment system (SBGTS) filters normally used to process releases via the containment ventilation pathway. There is no radiation monitor on the pipe and valves that comprise the DTV line. William J. Raymond, Senior Resident Inspector, Pilgrim Nuclear Power Station, USNRC, Region I, Branch 5, email correspondence, May 11, 2006.

In response to a question posed by the Town of Plymouth at a public meeting on June 21, 1990 about the decontamination factors for the torus pool of various isotopes, the NRC spokesperson responded that, "Except for the noble gases (consisting of the isotopes of Xenon and Krypton), which are not retained in the pool to any significant

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[23] Operating License Renewal Stage, E.2.3 Final Screening and Cost Benefit Evaluation of SAMA Candidates (Phase II). "Values for avoided public and occupational health risk were converted to a monetary equivalent (dollars) via application of the NUREG/BR-0184 (Reference E.2-19) conversion factor of $2,000 per person rem and discounted to present value. Values for avoided off-site economic costs were also discounted to present value."

degree, the suppression pool is highly effective in scrubbing out and retaining particulate and volatile fission products. Calculations as well as tests indicate that the suppression pool would be expected to have a realistic decontamination factor (DF) for particulate and volatile fission products of about 100, depending upon the accident sequence and the temperature of the water. This means that about 1% of the particulate and volatile radioactivity entering the pool would be released to the atmosphere, and about 99% would be retained within the pool." Although the NRC spokesman appeared to dismiss this as a trivial release, Dr. Frank von Hippel analyzed the applicant's response and stated that there is an internal contradiction in what we are being told. "The NRC believes that the release from a severe core-melt accident would be reduced [by the suppression pool] by a factor of one hundred. This is considerably more optimistic than estimated in the NRC's first study on the subject. WASH-1400, *The Reactor Safety Study*, WASH-1400 (1975). *Also known as The Rasmussen Report.* Also, the contention is that the reduction by a filtration system would have zero benefit. Here the contenders seem to be assuming that a factor of one hundred equals 100%. That is false. Even a release of on the order of 1 percent of the core's radioactive iodine and cesium would be a very severe event." Frank Von Hippel, Program of Science and Global Security, Princeton University, e-mail correspondence, March, 19, 2006.

In its Environmental Report, Entergy analyzes the benefits of installing a filter to the torus vent in the course of reviewing possible severe accident mitigation alternatives. The Pilgrim ER states, "Filtered Vent: This analysis case was used to evaluate the change in plant risk from installing a filtered containment vent to provide fission product scrubbing. A bounding analysis was performed by reducing the successful torus venting accident progression source terms by a factor of 2 to reflect the additional filtered capability. Reducing the releases from the vent path resulted in **no benefit**. This analysis case was used to model the benefit of phase II SAMAs 2 and 19." (E.2-5). The Report then states, "Basis for Conclusion: Successful torus venting accident progressions source terms are reduced by a factor of 2 to reflect the additional filtered capability. The cost of implementing SAMA at Peach Bottom was estimated to be $3 million. Therefore this SAMA is not cost effective for [Pilgrim]." (E.2-24). (emphasis added) In other words, as

they show in Table E.2-1, Entergy has determined that in return for a cost of $3,000,000.00, there will be no (0.00%) benefit to public health and safety.

It is not clear to Petitioners how it is possible to find zero (0.00%) benefit from installing a filter that would reduce by a factor of two the radioactive venting to the public in the case of a severe accident. Unfiltered venting has been judged unsafe by all regulatory agencies outside the United States. David C. Dixon, *Pilgrim Direct Torus Vent System*, Presentation to Massachusetts Joint Committee on Energy (February 27, 1990). In its analysis of several risk contributors to Core Damage Frequency in Section E.1, the disposition of those events in Table E.1-3 frequently included "venting via DTV path to reduce containment pressure." In other words, a filter in the torus vent could reduce the impact in ***many*** possible severe accidents. The only conclusion to draw from the outcome of the DTV filter SAMA analysis is that, as discussed above, Entergy has used the MACCS2 code to downplay the health and economic costs of severe accidents and used the Probabilistic Safety Analysis (PSA) model to make the benefits of mitigation appear to be zero.

3.4 Conclusion

The SAMA analysis included in the Pilgrim Environmental Report is incomplete. Not only does the probabilistic modeling for severe accidents artificially make consequences appear insignificant, but the Applicant has used incomplete and incorrect input parameters into the MACCS2 code. The question of whether these deficiencies have led to incorrect conclusions about each mitigation alternative is beyond the scope of this contention. However, Petitioners offer the direct torus vent filter as an example of how this cost benefit equation might have been skewed in favor of no mitigation. In *Duke Energy Corp.*, *supra* at13, the licensee argued that NEPA could not require it to implement any particular SAMA, regardless of the how the cost benefit calculations come out, and therefore there was no remedy possible for the Petitioners. But the board rejected this argument, saying "While NEPA does not require agencies to select particular options, it is intended to 'foster both informed decision-making and informed public participation, and thus to ensure the agency does not act upon incomplete

information, only to regret its decision after it is too late to correct' (*citing Louisiana Energy Services* (Claiborne Enrichment Center), CLI-98-3, 47 NRC 77, 88 (1998))." It then said "if 'further analysis' is called for, that in itself is a valid and meaningful remedy under NEPA." In this contention, Petitioners assert that the Applicant has drastically under counted the costs of a severe accident, and this could have led it to erroneously reject mitigation alternatives. Further analysis is called for.

Contention 4: The Environmental Report Fails To Address Severe Accident Mitigation Alternatives (SAMAs) Which Would Reduce the Potential for Spent Fuel Pool Water Loss and Fires

4.0 Contention

The Environmental Report is inadequate because it fails to address the environmental impacts of the on-site storage of spent fuel assemblies which, already densely packed in the cooling pool, will be increased by fifty percent during the renewal period. A severe accident in the spent fuel pool should have been considered in Applicant's SAMA review just as accidents involving other aspects of the uranium fuel cycle were. In addition, new information shows spent fuel will remain on-site longer than was anticipated and is more vulnerable than previously known to accidental fires and acts of malice and insanity. The ER should address Severe Accident Mitigation Alternatives that would substantially reduce the risks and the consequences associated with on-site spent fuel storage. Petitioners have outlined some of these alternatives.

4.1 The Contention is within the Scope of these proceedings

The contention is within the scope of these proceedings because Severe Accident Mitigation Alternative (SAMA) analyses are within the scope of a license renewal proceeding. Any exemption in the Generic Environmental Impact Statement (GEIS, NUREG 1437) and 10 CFR §51.53 for spent fuel storage covers normal operations only, not severe accidents. A severe accident in the spent fuel pool needs to be considered as part of the SAMA analysis, just as severe accidents in the core of the facility were considered by the Applicant. In addition, Petitioners have brought forth new and significant information that makes consideration of the spent fuel pool necessary under NEPA.

4.1.1 Category 2 issues are within the scope of these proceedings

Under 10 CFR §2.309, a petitioner is required to show that the issue raised in the contention is within the scope of the proceeding. The National Environmental Policy Act (NEPA), 42 USC § 4332, is the "basic charter for protection of the environment." 40

CFR § 1500.1(a). Its fundamental purpose is to "help public officials make decisions that are based on understanding of environmental consequences, and take decisions that protect, restore and enhance the environment." 40 CFR § 1500.1(c). The NRC regulations implementing NEPA for Nuclear Plant license renewals are in 10 CFR § 51(c) "Operating license renewal stage." In its application for license renewal of PNPS, Entergy was required under 10 CFR § 51 to provide an analysis of the impacts on the environment that will result if it is allowed to continue beyond the initial license. The regulation governing licensing renewals requires the Applicant for renewal to submit an Environmental Report. 10 CFR 51.53(c)(1). The NRC then uses the ER to prepare an Environmental Impact Statement or Environmental Assessment, although the NRC has an independent obligation to "evaluate and be responsible for the reliability" of the information. 10 CFR §51.70. The primary method by which NEPA ensures that its mandate is met is the "action-forcing" requirement for preparation of an EIS. *Robertson v. Methow Valley,* 490 U.S. at 348-49 (1989). The environmental impacts that must be considered in an EIS include those which are "reasonably foreseeable" and have "catastrophic consequences, even if their probability of occurrence is low . . ." 40 CFR §1502.22(b) (1). The fact that the likelihood of an impact may not be easily quantifiable is not an excuse for failing to address it in an EIS. NRC regulations require that "to the extent that there are important qualitative considerations or factors that cannot be quantified, these considerations or factors will be discussed in qualitative terms." 10 CFR§51.71.

In a petition for intervention, contentions that seek compliance with NEPA must be based on the applicant's Environmental Report (ER). 10 CFR§2.309(f)(2). Under 10 CFR §51 (c)(3)(ii) the plant is required to provide an ER that contains analyses of the environmental impacts of the proposed action, including the impacts of refurbishment activities, if any, associated with license renewal and the impacts of operation during the renewal term for those issues identified as Category 2 issues in Appendix B to subpart A of that part. Under 10 CFR §51(c)(ii)(L) "if the staff has not previously considered severe accident mitigation alternatives for the applicant's plant in an environmental impact statement or related supplement or in an environmental assessment, a consideration of alternatives to mitigate severe accidents must be provided." Severe

Accidents are listed as a Category 2 issue in a subsection of Appendix B entitled "Postulated Accidents." Under "Severe Accidents", it states "the probability weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to ground water, and societal and economic impacts from severe accidents are small for all plants. However, alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives." Contentions implicating Category 2 issues ordinarily are deemed to be within the scope of license renewal proceedings. *See Turkey Point, supra* at 11-13. As PNPS did not consider mitigation alternatives for severe accidents in the environmental impact statement of its original licensing, this issue is within the scope of this proceeding.

4.1.2 A Severe Accident involving the spent fuel pool is a Category 2 issue

For issues listed in Appendix B to Subpart A of 10 CFR 51 as Category 1 issues, the Commission resolved the issues generically for all plants and they are not subject to further evaluation in any license renewal proceeding. See 61 Fed. Reg. 28, 467 (1996). The Applicant may assert that since "on-site spent fuel" is listed separately under "Uranium Fuel Cycle and Waste Management" in Appendix B as a Category 1 issue, it does not need to be evaluated for Severe Accident Mitigation Alternatives. However, a proper reading of this Appendix makes it clear that spent fuel pools are not, and should not be, categorically excluded from a SAMA analysis. The rather long section called "Uranium Fuel Cycle and Waste Management" in the Appendix (which includes on-site spent fuel) deals with the issue of off-site radiological impacts of the fuel cycle and waste management during ***normal operations***. It also refers to certain generic issues like the proposed long term waste repository at Yucca Mountain and high level waste transportation. This section addresses impacts based on normal operating conditions at the plant in a generic way, and designates them Category 1 issues, and outside the scope of relicensing proceedings. The NUREG-1437 6.4.6.7 explains the Category 1 finding for on-site spent fuel storage and concludes "Radiological impacts will be well within regulatory limits; thus radiological impacts of on-site storage meet the standard for a conclusion of small impact." Surely since it contemplates remaining within regulatory

limits the Agency refers here to normal operations, not severe accidents. A severe accident is, by definition, outside of regulatory limits.[24]

In contrast, the section titled "Postulated Accidents" is very short. It is divided into only two sections, "Design Basis Accidents", which have been dealt with generically by the NRC and thus are Category 1, and the other dealing with the site specific impacts of Severe Accidents. This section is deceptively short – however in its purpose and function it requires the operator to consider a very broad range of possible accidents and mitigation alternatives to reduce the impacts of those accidents. Applicants for license renewal take the mandate to consider mitigation alternatives seriously – hence Entergy has devoted 176 pages to analyzing various facets of its operations in order to consider ways of reducing the consequences of a severe accident.

4.1.3 Applicant has included other accidents involving the Uranium Fuel Cycle in its SAMA analysis demonstrating it agrees that these are within the Scope of these proceedings

Many of the Severe Accidents considered in Entergy's ER involve "The Uranium Fuel Cycle," although again, these were considered Category 1 for the purposes of normal operations in Appendix B. For example in Table E.2-1 of Appendix E of the application "Summary of Phase II SAMA Candidates Considered in Cost-Benefit Evaluation" Applicant considered several mitigation alternatives that could prevent a core melt at the facility, although this obviously encompasses an accident in "The Uranium Fuel Cycle." The idea that the spent fuel pool is somehow outside this analysis, and that even if mitigation alternatives are readily available and cost effective the plant need not consider them, is ridiculous. The spent fuel pool is a structure that is part of the facility

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[24] The term "accident" refers to any unintentional event outside the normal plant operational envelope that results in a release or the potential for release of radioactive materials into the environment. Generally, the U.S. Nuclear Regulatory Commission (NRC) categorizes accidents as "design basis" (i.e., the plant is designed specifically to accommodate these) or "severe" (i.e., those involving multiple failures of equipment or function and, therefore, whose likelihood is generally lower than design-basis accidents but where consequences may be higher), for which plants are analyzed to determine their response. NUREG-1437, 5.2.1 General Characteristics of Accidents.

and although some aspects of its environmental impacts (off site radiological impacts during normal operations; prospects of long term storage) have been taken off the table, it is still vulnerable to severe accidents and thus within the realm of a proper SAMA analysis. By including other aspects of the Uranium Fuel Cycle in its SAMA analysis, Applicant has demonstrated that it agrees with this reading of Appendix B. The Category 1 topics under "Uranium Fuel Cycle and Waste Management" refer to environmental impacts during ***normal operations*** of the plant and do not exclude a consideration of severe accident mitigation.

4.2 The Issue raised in this Contention is Material to these proceedings

10 CFR 2.309(f)(iv) requires that the Petitioner "Demonstrate that the issue raised in the contention is material to the findings the NRC must make to support the action that is involved in the proceeding." In discussing the materiality requirement, the Atomic Safety and Licensing Board considering the license renewal for Millstone Nuclear Power Station stated "In order to be admissible, the regulations require that all contentions assert an issue of law or fact that is material to the outcome of a licensing proceeding; that is, the subject matter of the contention must impact the grant or denial of a pending license application. Where a contention alleges a deficiency or error in the application, the deficiency or error must have some independent health and safety significance." *Millstone, supra* at 7, and *see Private Fuel Storage, supra* at 179-180. The deficiency highlighted in this contention has enormous independent health and safety significance. By not performing a SAMA analysis on the potential for fires in its spent fuel pools, Applicant is not just failing to provide the NRC with all possible mitigation alternatives, it is also potentially putting the public and the environment at great risk. The Environmental Report's SAMA analysis is deficient and that deficiency could significantly impact health and safety.

4.3 An Adjudicatory Hearing is the only way to properly address Petitioners' concerns

The Licensing Board may determine that many of the issues raised in Petitioners contentions, including spent fuel environmental impacts and security, have been dealt

with generically already by the NRC, and any complaints about the treatment of these topics or enforcement of these rules should be raised by Petitioners as part of a 2.206 petition or by filing a rulemaking petition under 10 CFR § 2.802. *See for example, Turkey Point, supra* at 18, and *In the Matter of Amergen Energy Company, LLC* (License Renewal for Oyster Creek Nuclear Generating Station) ASLBP 06-844-01-LR p. 14, fn 9. (2006). In anticipation of this objection, Petitioners have set forth in Exhibit C a partial list of these and other concerns that have been brought to the NRC's attention by Petitioners and other citizens groups over the last 20 years. Despite these laborious efforts by the public to raise their legitimate safety and environmental concerns, the NRC has granted only one of the dozens of 2.206 petitions submitted.[25] In addition, NRC rules preclude any appeal of a 2.206 decision, and "the hearing rights available through a section 2.206 petition are scarcely equivalent to, and not an adequate substitute for, hearing rights available in a licensing proceeding." *Washington Public Power Supply System* (WPPSS Nuclear Project No. 3), ALAB-747, 18 NRC 1167, 1175-77 (1983). In addition, rulemaking under 10 CFR §2.802 takes a minimum of three years and can take up to nine years.[26] By the time these issues are addressed in a rulemaking proceeding, this re-licensing process will be over and PNPS would be operating without these issues being resolved. Because of barriers (not the least of which is the cost to public interest groups of hiring qualified legal representation and experts) which have barred concerned citizens from effective participation in rulemaking and enforcement in the past, Petitioners assert that license renewal is the proper and appropriate time to address safety and environmental issues that are of concern to the public. Linking agency action in license renewals to effective and meaningful reviews of safety and environmental concerns is required by National Environmental Policy Act and by the Atomic Energy Act.

[25] Submitted by T. Cochran of the NRDC in 1997.

[26] There is no way to predict the length of time before the DBT rulemaking process will be complete. A spokesman for NRC's Region I said, "[I]t takes years for the rulemaking process to be carried out...." Nucleonics Week, July 14, 2005. He noted that NRC review of rulemaking generally takes two and a half years, but could take much longer, and in at least one case, nine years.

4.4 Basis

Petitioners consider the spent fuel pool subject to a SAMA analysis just as consideration of possible core melt scenarios were. They are all part of the "Category 1 - Uranium Fuel Cycle" for normal operations, but subject to SAMA analysis for events that are outside normal operations. In addition, a SAMA analysis of spent fuel pool fires is necessary because new information shows that (1) spent fuel will remain on site longer than anticipated and (2) the risk of spent fuel pool fires is greater than previously thought. In addition, Petitioners will outline some mitigation alternatives that should have been considered.

4.4.1 Storage of spent fuel should be addressed in the Application's SAMA analysis because new information indicates that it is likely to remain on-site longer than was originally anticipated.

In 1982, the Nuclear Waste Policy Act (NWPA, 42 USC§ 10101) was passed whose principal purpose was to establish a scheme for siting and licensing a permanent repository for spent reactor fuel and other high level radioactive waste (HLW). For interim storage of HLW, the NWPA authorized the Commission to take necessary actions to "encourage and expedite the effective use of available storage, and necessary additional storage, at the site of each civilian nuclear power reactor," to the extent these activities are consistent with "the protection of the public health and safety, and the environment." 42 USC § 10152.

The license renewal application does not address Severe Accident Mitigation Alternatives for storage of spent fuel assemblies during the renewal period even though the spent fuel pool will be at maximum capacity by 2012 and there are no prospects for off-site storage in the foreseeable future. The ER contains only one vague sentence relating to the storage of spent fuel generated during the 20 year renewal period, and no acknowledgment of its environmental impacts.[27] This treatment is consistent with the

[27] "The spent fuel assemblies are then stored for a period of time in the spent fuel pool in the reactor building and may later be transferred to dry storage, if needed, at an onsite interim spent fuel storage installation provided necessary regulatory approvals are obtained." PNPS Application ER, section 3.2.3, p.3-4.

NRC's long-standing policy of separating reactor licensing decisions from high level radioactive waste storage concerns. The rationale for this seemingly bizarre separation of issues is grounded in the agency's Waste Confidence Ruling in 10 CFR §51.23, 49 FR 34694, Aug. 31, 1984, as amended at 55 FR 38474, Sept. 18, 1990, which reflects the Agency's confidence back in 1984 that a long term repository would be in place in the near future to accept high level radioactive waste from power stations. This ruling states that until then nuclear facilities can safely store their waste on-site for a period of 30 years after cessation of operations (whether that be at the end of the license or its renewal period). Although 10 CFR §51.23(c) also says "This section does not alter any requirements to consider the environmental impacts of spent fuel storage during the term of a reactor operating license or a license for an ISFSI in a licensing proceeding," the Commission also deals with the impacts during operations generically. NUREG – 1437, The Generic Environmental Impact Statement (GEIS) for License Renewal of Nuclear Plants (1996) and 10 CFR §51 Appendix B to Subpart A states: "The expected increase in the volume of spent fuel from an additional 20 years of operation can be safely accommodated on-site with small environmental effects through dry or pool storage at all plants if a permanent repository or monitored retrievable storage is not available." However, the NRC's NEPA regulations create an exception to this rule where there is "new and significant information regarding the environmental impacts of license renewal of which the applicant is aware." 10 CFR § 51.53(c)(iv). In other words, if there is new information relevant to this finding, the Environmental Report submitted with the application for license renewal must address these impacts.

In the years since the Waste Confidence Ruling and the GEIS were promulgated the nation's plan for permanent high level radioactive waste storage at Yucca Mountain has run into one obstacle after another, and confidence in the "Waste Confidence Rulemaking" has been shaken. In his pre-filed testimony before the Public Service Board of Vermont, on January 17, 2006, Dr. Gordon Thompson described why "there is near-universal agreement that the repository will not open in 2010, and great uncertainty about

when it might open thereafter."[28] And when it does actually open, it would not have enough capacity to accept all of the waste generated by Pilgrim and the forty other nuclear plants that have approval to operate for another 20 years. The Yucca Mountain repository will fill to capacity shortly after it opens.[29] Further, there is no guarantee where Pilgrim would stand on the federally-established shipping schedule if and when a federal repository opens and there is no requirement for Pilgrim to send its waste. Licensees can trade or sell their place on the shipping schedule.

Dr. Thompson also discussed the other unlikely off-site prospects for management of spent fuel. The only other off-site options currently proposed for managing high level radioactive waste from nuclear plants are re-processing and interim off-site storage in Skull Valley, Utah. Prospects for reprocessing nuclear fuel are at least 50-60 years in the future, according to the Nuclear Energy Institute.[30] Storage of high level radioactive waste at the Skull Valley Goshute Indian Reservation in Utah has run into obstacles as well, as acknowledged by Entergy Executive Vice President Curt L. Hebert Jr. And opposition to the proposed interim fuel storage continues.[31] In addition,

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[28] In the Matter of the Petition of Entergy Nuclear Vermont Yankee, LLC, and Entergy Nuclear Operations, Inc., for a Certificate of Public Good, under 30 V.S.A. 248, to Construct a Dry-Fuel-Storage Facility at the Vermont Yankee Nuclear Power Station.

[29] Yucca Mountain is being designed to hold 77,000 tons of waste. By the time Pilgrim's license expires, 2012, there will be about 60,000 tons of waste waiting in more than 30 states. 40 reactors have already been approved to operate an additional 20 years, generating tons of waste. President Bush's energy plan calls for building new reactors and each power plant generates about 2,000 more tons a year. Yucca is designed to process 3000 tons per year. If nuclear plants generate 2,000 tons a year, the best that they can do at Yucca is catch up by 1,000 tons a year. With the backlog that means it would take roughly 60 years to get the new waste to Yucca. However, shortly after Yucca opened, it would be filled to capacity. *In Bush Seeks to Jump-Start Nuclear Power, Proposed Test of New Waste-Reprocessing Methods, Aims to Ease Concerns Over Storage*, John J. Fialka, The Wall Street Journal, January 26, 2006; Page A4.

[30] Nuclear Energy Initiative Holds Uncertainties, Bush Plan Could Cut Dependence on Oil but Relies on Unproven Technologies, Guy Gugliotta, Washington Post ,Sunday, February 19, 2006; A09. In response to a claim that the Bush Administration's proposed reprocessing system may be ready by 2025, Steven Kraft, senior director of used fuel management for the Nuclear Energy Institute, an industry policy group, voiced doubts: "This is a matter of developing future technologies, and those technologies are 50 to 60 years away." *In Bush Seeks to Jump-Start Nuclear Power, Id.* at A4.

[31] Louisiana-based Entergy Corp. sent a letter to Sen. Orrin Hatch and the Utah congressional delegation indicating that it would "hold in abeyance" future investments for construction of the PFS site. "We recognize the political obstacles to finding solutions to management of spent fuel from nuclear plants and believe the Utah facility is probably not the best solution to be pursued at this time," wrote Entergy

any off-site solution to highly radioactive spent fuel storage also includes the transportation of that waste to the site. The transportation of high level radioactive waste, despite the generic high confidence written into the NRC's regulations, will also entail overcoming substantial technical, political, and legal challenges.[32]

Executive Vice President Curt L. Hebert Jr. *Nuclear waste storage: Four companies hold a 68% interest in the project*, Robert Gehrke, The Salt Lake Tribune, 12/21/2005.
"Politicians, four-wheelers, green activists, business and even the top leaders of The Church of Jesus Christ of Latter-day Saints - they all told the U.S. Bureau of Land Management what they think about plans to transport reactor waste to the Skull Valley desert." *Cause unites N-dump foes,* Judy Fahys, Salt lake Tribune, May 9,2006.
"The House Energy and Water Development Subcommittee earmarked $30 million Thursday for interim nuclear-waste storage, and with the money came a promise from the subcommittee's chairman that he was not trying to force nuclear waste on any community. The chairman and the Energy Department have insisted they are not looking to put nuclear waste at the Private Fuel Storage site on the Skull Valley Goshute Indian reservation in Tooele County. But any talk of an interim site keeps the PFS idea alive. 'We're skeptical the $30 million for interim storage won't target Skull Valley,' said Vanessa Pierce, program director at the Healthy Environment Alliance of Utah. "With its NRC license, right now PFS is the only game in town. And that's why we're counting on Sen. Bennett to cut this money when it gets to his committee in the Senate." "I would not put this in a community that is not willing to accept it," Hobson said. Hobson told Rep. Rob Bishop, R-Utah, during an earlier floor debate that he was not looking to put the waste into a private site. "There's no doubt Utah is an unwilling community," said Bishop's chief of staff, Scott Parker. "The department still needs permission from Congress to move along with an interim plan before the money could actually be spent on the effort. Sen. Bob Bennett, R-Utah, sits on the Senate Appropriations Committee. *House panel allocates $$ for nuclear storage: Chairman says he's not forcing it on a community,* Suzanne Struglinsky, Deseret Morning News, May 13, 2006.

[32] Obstacles and the bases of legal opposition have been outlined to the US Congress by the State of Nevada. Testimony points to a variety of transportation issues: more than 123 million citizens reside within one-half mile of proposed transportation routes, some if not many will raise objection; DOE prefers shipment by rail, yet many sites do not have rail access and rail access to Yucca is not available; terrosism risks associated with rail transport; DOE has never done an evaluation of the nuclear criticality risk of spent fuel casks getting struck by state-of-the art-armor piercing weapon; few casks even exist today. *Testimony before the U.S. House of Representatives, Committee on Transportation and Infrastructure, Subcommittees on Railroads and Transportation and Hazardous Materials,* by Kenny C. Guinn, Governeor of the State of Nevada, Congresswoman Shelley Berkley (D-NV), Marvin Resnikoff, Robert J. Halstead, Professor James David Ballard, (April 25, 2002).

Questions remain over the safety of nuclear casks in the event of a sustained, hot fire, a review panel of the US National Academy of Sciences has concluded. An NAS report released in Washington DC found there are "no fundamental technical barriers" to safe transportation, but that a number of "serious challenges" remain. Assuming no new plants are built, disposing of fuel from the US's 112 operating plants will require a two-decade-long programme of daily shipments, and more planning needs to be done for managing this massive operation, the report says. The report assessed the adequacy of planning for every kind of accident scenario, but not the potential for deliberate acts such as terrorist attacks. To evaluate that aspect, it says, would require creation of a new committee with full access to classified materials. But since the Sept. 11, 2001, terrorist attacks, the biggest concern has been terrorist attacks -- and about that danger, the report is silent because its investigators were unable to obtain adequate information from the U.S. Nuclear Regulatory Commission.

In light of these developments, the NRC's policy of continuing to have confidence that the waste issue will easily be dealt with in the future, and therefore separating decisions regarding generation of waste from decisions about where and how it will be stored, needs to be re-evaluated. The likelihood that all of the high level radioactive waste at Pilgrim will be moved off-site before the year 2062 (renewal period plus 30 years) is dwindling. On-site storage is going to be a reality for generations. States and local communities recognize this and accordingly some[33] have already enacted legislation to enable them to tax licensees for the privilege of storing dry casks on-site and other communities, including Pilgrim's host community, Plymouth, Massachusetts, have filed similar legislation. According to a recent statement in the Boston Globe, the spent-fuel issue does concern the Pilgrim plant operator. "We will run out of space in 2012," Tarantino said. "This was never intended to be a repository for any length of time."[34] These communities recognize that although they did not bargain to be nuclear waste storage sites, in reality they have become so and they should be justly compensated. Licensees also are aware that on-site storage is a reality. Consequently, suits have been brought against DOE by licensees, including Entergy, to compensate them for having to store waste longer than anticipated. *DOE Breached Contract, Says Court Agency Can Be Sued for Failure To Begin Taking Used Nuclear Fuel*, Nuclear Energy Insight, October 2000; *Large utility makes deal on nuke waste. Government to pay company to keep on-site storage*, Sun Washington Bureau, Suzanne Struglinski, August 11, 2004.

Entergy is aware that this fuel is likely to remain on-site for far longer and in far higher quantities than was originally planned and designed for, and is ultimately responsible for the safety of spent nuclear fuel stored at the plant. Therefore the Environmental Report should address the likely impacts of on-site storage for the foreseeable future. Mitigation strategies that could prevent severe accidents or reduce their consequences should be considered.

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[33] Examples include Maine, Minnesota, Vermont

[34] Pilgrim spokesman David Tarantino to the Boston Globe. *Decision Looms Over Pilgrim*, Carolyn Y. Johnson, Boston Globe (April 16, 2006).

Entergy's application does not address the environmental issue of the storage of existing waste in its ER, and does not describe its plans for the excess capacity of spent fuel that will be generated during an additional 20 years of operations. The original license for Pilgrim allowed the storage of 880 spent fuel assemblies in its cooling pool. In 1994, the plant's then owner, Boston Edison, Inc., applied for and was granted permission to re-rack the fuel in order to accommodate 3,859 assemblies, the amount that would be generated through the end of the current license in 2012. NUREG 1437 § 6.4.6.2 states that the amount of additional waste generated during license renewal will be a function of each plant's refueling schedule but that the total accumulated volume of spent fuel after an additional 20 years of operation of a plant would be roughly 50% more than at the end of 40 years of operation (DOE/RW-006). Using this calculation, Pilgrim will presumably have generated a total of 5,785 spent fuel assemblies by the end of its renewal period, 2032.

In 10 CFR §51.53 (c)(2) "Post Construction Environmental Reports" says that the Environmental Report must contain a description of the proposed action including plans to modify the facility or its procedures in accordance with 54.21. However, in its Environmental Report Appendix E 3.2.3, Entergy dismisses the issue of additional storage with one vaguely worded sentence: "The spent fuel assemblies are then stored for a period of time in the spent fuel pool in the reactor building and may later be transferred to dry storage, if needed, at an onsite interim spent fuel storage installation provided necessary regulatory approvals are obtained." Whereas some other plants have applied to increase the capacity of their spent fuel storage on-site prior to applying for license renewal,[35] Entergy appears to be waiting until the capacity at Pilgrim runs out before taking this step, confident that they can obtain permission to generate an additional 20 years of waste before formally addressing the issue of what to do with it. While this approach might have made sense when there was confidence in the Waste Confidence Rule, today it makes more sense and is more protective of the environment to assess the

[35] Independent Spent Fuel Storage Locations on site at reactors that have completed the license renewal process include: Calvert Cliffs; Oconee; Hatch; Peach Bottom; McGuire; Robinson; Dresden; Arkansas; Point Beach. Independent Spent Fuel Storage Locations on site at reactors whose license renewal is under review includes: Palisades; Oyster Creek; Vermont Yankee as of Match 2003. NRC website spent fuel-storage-locations.

impacts of on-site spent fuel storage ***before*** permission is given to generate more waste. To do otherwise would risk prejudging the findings on subsequent storage.

4.4.2 New information shows that the risk of an accidental spent fuel fire at a reactor like Pilgrim is greater than previously thought

The NRC has never performed an EIS that addresses the potential for, and impacts of, the onset of exothermic oxidation reactions in a spent fuel pool. NUREG 1437 § 6.4.6 simply states "Inadvertent criticality and acute occupational exposure are remote risks of dense-racking (DOE/RW-0220)." Yet, in a report published in October 2000 and issued in January 2001, the NRC Staff has conceded that if the water in any densely packed spent nuclear fuel pool is lost, even a year and longer after discharge, the fuel will heat up to the point where its zircoloy cladding will melt and then catch fire.[36] The resulting fire will not be able to be extinguished and has the potential of significantly contaminating hundreds of miles downwind. *Spent Fuel Heatup Following Loss of Water During Storage*, Allen Benjamen et al. (Sandia National Laboratory, NUREG/CR-0649, SAND77-1371, 1979), fig.14.

4.4.2. a The risk of fire is increased because the spent fuel is densely packed

U.S. nuclear power plant operators have dealt with the lack of an off-site destination for their accumulating spent fuel by packing as many fuel assemblies as possible into their storage pools until capacity is met or exceeded. The original design density of spent fuel in the pools associated with BWRs had the fuel assemblies spaced out in a loose square array. The standard spacing for new dense-pack racks today is 23 cm - barely above the 21.4 cm spacing in reactor cores. *Reducing the Hazards from Stored Spent Power-Reactor Fuel in the United States*, Robert Alvarez, Jan Beyea, Klaus

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[36] A technical study of spent fuel accident risk, performed for the NRC by Sandia Lab, clearly stated that a catastrophic meltdown in the spent fuel pool of a nuclear power plant could cause fatal, radiation-induced cancer in thousands of people as far as 500 miles from the site. NUREG-1738 *Technical Study of Spent Fuel Accident Risk at Decommissioning Nuclear Power Plants* (2001).

Janberg, Jungmin Kang, Ed Lyman, Allison Macfarlane, Gordon Thompson, Fran N. von Hippel, Science and Global Security, 11: 16 (2003). This "dense-packed" fuel is kept sub-critical by enclosing each fuel assembly in a metal box whose walls contain neutron-absorbing boron. *Id.* These boron-containing partitions would block the horizontal circulation of cooling air if the pool water were lost, greatly reducing the benefits of mixing recently-discharged with older, cooler fuel. During a partial uncovering of the fuel, the openings at the bottoms of the spent-fuel racks would be covered in water, completely blocking air from circulating up through the fuel assemblies. The portions above the water would be cooled primarily by steam produced by the decay heat in the below-surface portions of the fuel rods in the assemblies and by blackbody radiation. *Id. at 17.* In the absence of any cooling, a freshly-discharged core generating decay heat at a rate of 100 kWt/tU would heat up adiabatically within an hour to about 600°C, where the zircaloy cladding would be expected to rupture under the internal pressure from helium and fission product gases,and then to about 900°C where the cladding would begin to burn in air. *Id.* The cooling mechanisms in a drained dense-packed spent-fuel pool would be so feeble that they would only slightly reduce the heatup rate of such hot fuel.

In 2001, the NRC staff summarized the conclusions of its most recent analysis of the potential consequences of a loss-of-coolant accident in a spent fuel pool as follows:

> "(I)t was not feasible, without numerous constraints, to establish a generic decay heat level (and therefore a decay time) beyond which a zirconium fire is physically impossible. Heat removal is very sensitive to . . . factors such as fuel assembly geometry and SFP (spent fuel pool) rack configuration . . . (which) are **plant specific** and . . . subject to unpredictable changes after an earthquake or cask drop that drains the pool. Therefore, since a non-negligible decay heat source lasts many years and since configurations ensuring sufficient air flow for cooling cannot be assured, the possibility of reaching the zirconium ignition temperature **cannot be precluded on a generic basis**." *Id. at 18.* (emphasis added)

4.4.2.b The cooling water in the spent fuel pool could be lost due to an accident

The cooling water in a spent-fuel pool could be lost in an accident or by a malicious act which results in drainage of the pool or boil off of the water in the pool. Possible causes of drainage include any damage to the structural integrity of the pool that drains the water at a rate that exceeds water makeup capability. *Nuclear Waste Disposal Crisis*, David Lochbaum, PennWell Books, PennWell Publishing Company, Tulsa, Oklahoma (1996) p.111. Events producing this failure mode include, for example, heavy loads dropping into the pool or onto its wall. David Lochbaum discusses (12) fuel handling events in his 1996 book. *Id.* Two of these occurred at Pilgrim. In January 1974, while transferring an irradiated fuel assembly from the spent fuel pool to the channel inspection facility at Pilgrim. The fuel assembly became detached from the main grapple and fell approximately 20 feet to the bottom of the pool. In December 1979, a new fuel assembly was dropped at Pilgrim while it was being transferred to its storage location in the pool. *Id.* at 167-169. And the Massachusetts DPU reported that on June 26, 1991, during the process of removing a fuel bundle from the [Pilgrim] reactor to the spent fuel pool, the refueling bridge grapple opened unexpectedly and a fuel bundle was dropped. MA. D.P.U. 92-1A-B.

There have been several instances where such accidents have caused rapid water loss. One occurred in 1994 at Edwin Hatch, Baxley Georgia (BWR). On Dec 1994 a core shroud head dropped into Unit I spent fuel pool from one foot above the water surface. The bolt which was 17 feet long and 3 inches in diameter, weighing 365 pounds, glanced off the side wall and fell to the bottom of the pool without hitting the storage racks or fuel assemblies. The bolt tore a 3 inch gash in the 3/16 of an inch thick stainless steel liner. Approximately 2,000 gallons of water was lost. The spent fuel pool water level dropped nearly two inches in 23 minutes. *Id.* at 112. The Hatch incident occurred less than a year after a screwdriver dropped into a spent fuel pool at a foreign reactor had similar results. On January 31, 1994, workers at Tricastin Until I in France were removing the control rod cluster guide tube from a spent fuel assembly. A 15 foot long screw driver weighing 44 pounds fell into the spent fuel pool and punctured the stainless steel liner. The level in the spent fuel pool dropped nearly four inches. *Id.* at 112.

In addition to the above scenarios, fuel pool cooling systems could malfunction bringing about accelerated water loss in the pool. Events producing this failure mode include a fuel pool cooling system pipe break and the failure of the system's heat removal function. Another scenario causing drainage would be a failure of inflatable and mechanical seals that allows water to leak from the pool into adjacent areas such as the containment, the shipping cask pit, and the fuel transfer tube. All spent fuel pools are connected via fuel-transfer canals or tubes to the cavity holding the reactor vessel. These can be partially drained through failure of the interconnected piping systems, moveable gates, or seals designed to close the space between the pressure vessel and its surrounding reactor cavity. A 1997 NRC Report (NUREG-1275) described two incidents of accidental drainage: Once the water level is below the top of the fuel, the gamma radiation would climb to 10,000 rems/hr at the edge of the pool and 100's of rems/hr in regions of the spent fuel pool out of direct sight of the fuel - because of the scattering of gamma rays by air and the building. Even at the lower radiation level, lethal doses would be incurred within an hour. Given such dose rates NRC staff assumed that further ad hoc interventions would not be possible. *Technical Study of Spent Fuel Pool Accident Risk at Decommissioning Nuclear Power Plants*, NUREG-1275, p. A1A-1 (1997).

Despite the fact that accidents like the ones described above can be easily envisioned and have in fact happened at Pilgrim and other plants, and could have caused a catastrophic loss of coolant water in the spent fuel pool, the ER does not include a SAMA analysis to look at mitigation alternatives that might reduce the likelihood or the impacts of these scenarios.

4.4.2. c The cooling water could be lost due to acts of malice or insanity

New information shows that spent fuel pools are structurally vulnerable to destructive acts of malice or insanity, and sabotage-induced pool fires. In a report issued in April 2005, entitled "Safety and Security of Commercial Spent Nuclear Fuel Storage Public Report" (hereinafter "NAS Safety Report") the National Academy of Sciences addressed the hazards of stored spent power- reactor fuel. The report concluded that reactor pools are especially attractive terrorist targets because of their large inventory of

radionuclides and consequent capability of immense destruction; they are particularly vulnerable to terrorist attack because they are less well protected structurally than reactor cores, and they typically contain inventories of medium and long-lived radionuclides that are several times greater than those in individual reactor cores. *Safety and Security of Commercial Spent Nuclear Fuel Storage Public Report*, National Academy of Sciences, p.36 (April 2005). A loss-of-pool-coolant event resulting from damage or collapse of the pool could have severe consequences. Severe damage of the pool wall could potentially result from several types of terrorist attacks, including attacks with large civilian aircraft, high-energy weapons, or attacks with explosive charges. *Id.* at 49.

A crash into the spent fuel pool by an aircraft would raise concerns of both puncture (see below) and fire. To study the potential for fire, researchers at the Sandia National Laboratory, using water to simulate kerosene, crashed loaded airplane wings into runways. They concluded that at speeds above 60 m/s (135 mph), approximately "50% of the liquid is so finely atomized that it evaporates before reaching the ground. If this were fuel, a fireball would certainly have been the result, and in the high-temperature environment of the fireball a substantially larger fraction of the mass would have evaporated." *Reducing the Hazards from Stored Spent Power-Reactor Fuel, supra* at 14. The blast that would result from such a fuel-air explosion might not destroy the pool but could easily collapse the building above, making access difficult and dropping debris into the pool. A small explosive laden plane could cause this catastrophic series of events.

Pilgrim's spent-fuel pool is located above ground level. Hence it could drain completely it could drain completely if either its bottom or sides were punctured. Concerns that the turbine shaft of a crashing high-speed fighter jet or an act of war might penetrate the wall of a spent-fuel storage pool and cause a loss of coolant led Germany in the 1970s to require that such pools be sited with their associated reactors inside thick-walled containment buildings. When Germany decided to establish large away-from-reactor spent-fuel storage facilities, it rejected large spent-fuel storage pools and decided instead on dry storage in thick-walled cast-iron casks cooled on the outside by convectively circulating air. The casks are stored inside reinforced-concrete buildings that provide some protection from missiles. *Id.* at 15. A terrorist attack with a shaped-

charge anti-tank missile could also puncture a pool. *Id.* at 16. The National Academy of Sciences reported to Congress last year that "successful terrorist attacks on spent fuel pools, though difficult, are possible." *NAS Safety and Security Report, supra* at 3. This report found that "[i]f an attack leads to a propagating zirconium cladding fire, it could result in the release of large amounts of radioactive material." Id. The long-term contamination consequences of such a fire could be "worse than those from the Chernobyl accident." *Id. at 45.*

4.4.2. d BWR Mark I & Mark II Reactors like Pilgrim are especially vulnerable

Pilgrim is distinguished by its obsolete Mark 1 containment design, which has been criticized since 1972. Concerns that the Mark I containment design will respond inadequately to deal with a large loss-of-coolant accident were first raised in a September 20, 1972 memorandum by Dr. S. H. Hanauer on behalf of the Atomic Energy Commission. IMO Boston Edison Co. (Pilgrim Nuclear Generating Station), Docket No. 50-293, 1987 NRC LEXIS 37 (1987). Beyond the questionable safety of the Mark I containment design, another specific design feature which justifies plant specific SAMA review of PNPS is its elevated spent fuel pool. GE Mark I (like Pilgrim) and Mark II Boiling Water Reactors are especially vulnerable to attack because they are located at the top of the reactor building, outside primary containment. "The spent fuel pool, (in GE Mark I BWR reactors) is located in the reactor building well above ground level. Most designs [including Pilgrim] have thin steel superstructures. The superstructures and pools were not, however, specifically designed to resist terrorist attack." *Id. at 41.* "The vulnerability of a spent fuel pool to terrorist attack depends in part on its location with respect to ground level as well as its construction. Pools are potentially susceptible to attacks from above or the sides depending on their elevation ....." *Id. at* 43. Prior to the National Academy Report, independent scientists from our leading universities came to the same conclusion. *Reducing the Hazards from Stored Spent Power-Reactor Fuel in the United States*, Robert Alvarez, Jan Beyea, Klaus Janberg, Jungmin Kang, Edwin Lyman, Allison MacFarlane, Gordon Thompson, Science & Global Security, Vol. 11, No.1, (2003).

Petitioners and others have outlined their concerns about the special vulnerability of BWR Mark I and Mark II Reactors in a petition to the NRC under 10 CFR § 2.206 entitled "Petition to the U.S. Nuclear Regulatory Agency Requesting Emergency Enforcement Actions To Address Structural Vulnerabilities of Boiling Water Reactors With Mark I and Mark II Containments and Their Irradiated Fuel Pools." (submitted August, 2004).[37] However, questions regarding the general operational safety of the Mark I design and the increased vulnerability of Pilgrim's elevated and poorly-protected spent fuel pool justify site-specific SAMA review.

4.4.2. e The NRC has demonstrated that it considers terrorist attacks on nuclear plants are foreseeable threats that must be addressed

Shortly after September 11, 2001 the NRC re-evaluated security threats against nuclear plants to determine potential "Design Basis Threats" (DBTs). The DBTs describe generically the security threats against which plant owners must design protections systems. Currently the NRC is proposing to amend its regulations that govern DBT requirements under 10 CFR §73. The proposed rule (RIN 3150-AH60) would revise the DBT requirements for radiological sabotage and theft or diversion of Strategic Nuclear Material. These new requirements make generically applicable the security requirements previously imposed on existing licensees by the NRC's April 29, 2003 DBT orders. However one of the major criticisms of the proposed rulemaking is that they do not include defenses from threats to spent fuel pools from the air, despite the recent NAS report that demonstrated that spent fuel pools are extremely vulnerable to this type of attack.[38]

In the NAS Safety Report, the committee found that because vulnerability is plant specific, a plant-by-plant vulnerability analyses should be performed. "Finding 3 D: The

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[37] The NRC denied the Petition despite the fact that the Petitioner's contentions were supported in large part by the National Academy's study.

[38] *2.206 Petition to Address Structural Vulnerabilities o Mark I and I BWRs and their Irradiated Fuel* (submitted August 2004) and Supplemental (Filed in April 2005) referring to NAS Report, *Safety and Security of Commercial Spent Nuclear Fuel Storage,* National Academy of Sciences, April 2005.

potential vulnerabilities of spent fuel pools to terrorist attacks are plant-design specific. Therefore specific vulnerabilities can only be understood by examining the characteristics of spent fuel storage at each plant." *NAS Safety and Security Report, supra* at 6 and 58. In addition, more than four years after September 11, 2001, the NAS expressed concern over NRC's slow pace: "...the Nuclear Regulatory Commission's analyses of spent fuel storage vulnerabilities have not yet been completed and actions to reduce vulnerabilities ...have not yet been taken. Moreover, some important additional analyses remain to be done. The slow pace in completing this work is of concern given the enormous consequences as described elsewhere in this report." *Id.* at 75.

The possibility of a terrorist attack on Pilgrim goes well beyond mere speculation. The 9/11 Commission has documented the fact that nuclear facilities had been among the original targets of the al Qaeda terrorists. "Indeed, KSM [Khalid Sheikh Mohammed] describes a grandiose original plan: a total of ten aircraft to be hijacked, nine of which would crash into targets on both coasts-they included those eventually hit on September 11 plus CIA and FBI headquarters, nuclear power plants, and the tallest buildings in California and the state of Washington." *The 9/11 Commission Report*, National Commission on Terrorist Attacks Upon the United States, p.154 (July 22, 2004).

4.4.2. f The Pilgrim spent fuel pool is particularly vulnerable to attack from the air

Pilgrim is located less than 40 miles from Logan International Airport in Boston, one of the country's busiest airports and the origin of two of the hijacked airplanes on September 11, 2001. As discussed above, the BWR Mark I reactors are particularly vulnerable to attacks on their fuel pools because these are located in the reactor building well above ground level and usually have thin steel superstructures. The superstructures and pools were not designed to resist terrorist attack, and are vulnerable to attack by large civilian aircraft. *NAS Safety and Security Report, supra* at 41 and 49. As stated earlier, the densely packed spent fuel pools are at much higher risk of a catastrophic fire than previously thought, even with a partial drop in the water level of the pool.

General aviation pilots are not screened before takeoff and the contents of general aviation planes are not screened at any point. General aviation includes more than 200,000 privately owned planes, which are located in every state at more than 19,000

airports. For example the following airports are within 10 nautical miles of Pilgrim: Double A, Carver; Jordan Hospital, Plymouth; Plymouth Municipal Airport, Plymouth; Russell Mill Pond, Plymouth; Sampson Pond, Carver; Wayne West, Carver, West Pond, Plymouth. Over 550 of these airports also provide commercial service. In the last five years, the GAO reported about 70 aircraft stolen from general aviation airports, indicating a weakness that could be exploited by terrorists. Neither the reactor building, control room nor spent fuel pool at Pilgrim are designed to withstand aircraft impacts or explosive forces. A large plane – or a light aircraft packed with high explosive – could do extensive enough damage to the pools to drain cooling water, causing the high-level waste to ignite and release lethal radioactive cesium over thousands of square miles.[39]

Despite the increased risk of terrorism, the increased risk of fire in densely packed spent fuel pools, being located in the fastest growing region of New England, its location near one of the busiest and expanding airports in the nation, and the fact that the design of the Pilgrim spent fuel pool is the most vulnerable to attack, Entergy has not addressed the issue of Severe Accident Mitigation Alternatives for an attack on its spent fuel pool.

In its response to the citizen's 2.206 petition regarding plant vulnerability, the NRC listed current measures that have been put in place to deal with the increased risks after September 11.

> "Nuclear plants incorporate structural features to protect against severe external events such as tornadoes, hurricanes, fires and floods. These structural features, supported by the deployment of effective and visible physical protection measures, provide a deterrent to terrorist activities. With respect to potential terrorist attacks by air, Federal efforts have increased substantially since September 11, 2001. Those efforts include enhanced airline passenger and baggage screening, strengthened cockpit doors, and the Federal Air Marshals program, among others. Federal law enforcement and intelligence agencies have

[39] The most common light aircraft in the U.S. is the Cessna Skyhawk. It can travel 687 miles, can carry 675 pounds, evade radar and deliver up to 1,000 pounds of high explosive. Hence these general aviation aircraft, with a suicidal terrorist and hundreds of pounds of explosives can be used as a poor person's Cruise missile. The FBI has reportedly been concerned about a scenario involving two light planes striking a nuclear plant – one after another. Military protection could not save PNPS. The two interceptor jets at Otis Airbase require a 10 minute mobilization time – likely to arrive and intercept too late. NRC's own study from 1982 stated an aircraft impact could "obliterate the reactor's primary core containment," release massive amounts of radiation, and kill thousands of people without any chance of evacuation. Control rooms, cooling pools filled with spent fuel rods, and other vital targets are even more vulnerable than the reactor itself. *Homeland Security: Nuke Plants are Suicide Hijacker Targets*, Stan Goff, Special Forces Veteran, (November 13, 2003).

> increased efforts to identify and mitigate potential aircraft-related threats before they can be carried out. In more than one case, the Department of Defense and Federal Aviation Administration (FAA) have acted to protect airspace above nuclear power plants in response to threats which were later determined to be non-credible. These and other government-wide efforts have improved protection against air attacks on all industrial facilities, both nuclear and non-nuclear. Nonetheless, nuclear plant licensees have well established emergency procedures and severe accident management guidelines that provide a means to help mitigate the potential consequences of terrorist attacks should they occur."[40]

These measures are inadequate on their face. Recent reports have demonstrated that airline security measures cannot keep even journalists from bringing banned items (including explosives) on board commercial airlines, much less deal with threats from organized and determined terrorists. The "no-fly" zone around Pilgrim seems to be shrinking yearly. Lower flight paths into and away from Logan International Airport were recently approved, allowing commercial airlines to fly directly over Plymouth and neighboring communities at lower altitudes. Private planes can be seen sight-seeing and performing aerial tricks in close proximity to the plant. The "well established emergency procedures and severe accident management guidelines" provide no real protection for Massachusetts citizens in the event of an attack on Pilgrim. The emergency preparedness has been dealt with primarily by shrinking the evacuation area to a more manageable size (see NUREG-0654, Supp 3) and the SAMA analysis presented by Entergy does not include accidental fires much less breaches to the spent fuel pool caused by an external attack.

NUREG-1437 5.3.3.1 states, "Although the threat of sabotage events cannot be accurately quantified, the commission believes that acts of sabotage are not reasonably expected. Nonetheless, if such events were to occur, the commission would expect that resultant core damage and radiological releases would be no worse than those expected from internally initiated events." This easy dismissal of the potentially serious and *different* effects from an act of sabotage ignores the fact that an attack from outside the plant would cause an immediate breach in the containment of the pool itself. Because of this fact a release of radioactive material could happen sooner than it would from an

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[40] *Of The Matter of Boiling water Reactors of Mark I and Mark II Designs*, J. E. Dyer, Director, DD-05-04.

internally initiated event. In addition, an internally initiated event would likely result from a series of escalating situations which might trigger operator responses. An act of sabotage from the outside would give no such warning.

4.4.2. g The consequences of water loss in the spent fuel pool caused by accident or terrorism could be catastrophic

The National Academy of Sciences Report described what would happen if a terrorist attack on the spent fuel pool leads to a zirconium cladding fire. The Academy stated that, "Such (zirconium cladding) fires would create thermal plumes that could potentially transport radioactive aerosols hundreds of miles downwind under appropriate atmospheric conditions." *NAS Safety and Security Report, supra* at 50. The excess cancer estimates from such an accident would be between 2,000 and 6,000 cancer deaths. *Id. at* 45. The damage which can be done by a large release of fission products was demonstrated in the Chernobyl accident.[41] The result from an accident in the spent fuel pool and release of radioactive material at Pilgrim could potentially be much more severe.[42]

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[41] More than 100,000 residents from 187 settlements were permanently evacuated because of contamination by Cs-137. Strict radiation-dose control measures were imposed in areas contaminated to levels greater than 15 Ci/km-2 of CS-137. The total area of this radiation-control zone is huge – equal to half of New Jersey. *Reducing the Hazards from Stored Spent Power-Reactor Fuel in the United States,* Robert Alvarez, Jan Beyea, Klaus Janberg, Jungmin Kang, Edwin Lyman, Allison MacFarlane, Gordon Thompson, Science & Global Security, Vol. 11, No.1, pages 7-10 (2003).

[42] Inventories of Cs-137 in PNPS fuel pool: PNPS' pool contains a much larger inventory of Cs than the 2 MegaCuries (MCi) that were released from the core of Chernobyl. PNPS' spent fuel pool currently has somewhat over 400 metric tons, and is licensed to hold over 600 metric tons. 400 tons of spent reactor fuel would contain 35 mega-curies (MCi) of Cs-137. If 10-100% of the Cs-137 in a spent fuel pool i.e. 3.5-35 MCi were released by a spent fuel fire to the atmosphere in a plume distributed vertically uniformly through the atmosphere's lower "mixing layer" and dispersed downwind in a "wedge model" approximation under median conditions (mixing layer thickness of 1 km, wedge opening angle of 6 degrees, wind speed of 5 m/sec, and deposition velocity of 1cm/sec) then 37,000-150,000 km-2 would be contaminated above 15 Ci/km-2, 6,000-50,000 km-2 would be contaminated to greater than 100 Ci/km-2 and 180-6,000 km-2 to a level greater than 1000 Ci/km-2. Although a number of isotopes are of concern, we focus on Cs-137. It has a half-life of 30-years, is relatively volatile and, along with its short lived decay product, barium-137 (2.55 minute half-life), accounts for about one half of the fission product activity in 10-year old spent fuel. It is a potent land contaminant because 95% of its decays are to an excited state of BA -137, which de-excites by emitting a penetrating (0.66-MeV) gamma ray. *Id.* at 7.

Given the extreme consequences of such an event, any foreseeable possibility of such a fire needs to be considered and its impacts addressed. And as described below, mitigation alternatives are available to decrease the likelihood of fire in these pools.

4.4.3 There are mitigation alternatives that would decrease the likelihood of a fire in the Pilgrim Spent Fuel Pool

For the purposes of raising an admissible contention a thorough examination of mitigation alternatives should not be required, since that would in effect be requiring the petitioner to prove the contention itself, rather than just demonstrate a deficiency in the Applicant's ER. The Commission has consistently ruled that in deciding whether the NRC's admissibility standard is satisfied, the substantive merits of a contention may not be reached. *Sierra Club v. NRC*, 862 F.2d at 228, citing *Texas Utilities Electric Co.* (Comanche Peak Steam Electric Station, Unit 1), ALAB-868, 25 NRC 912, 931 (1987). Despite this, Petitioners submit the work of Dr. Gordon Thompson, who has provided a detailed analysis of mitigation alternatives and their approximate costs. Some of these alternatives, including reconfiguring the spent fuel pool and installation of automated spray cooling systems, would yield a slight reduction in the risk of spent fuel pool fires but would not provide an adequate or a long term solution. However, the most important change that Entergy can make to reduce the risk of this kind of severe accident would be to immediately implement a strategy of using low density pool storage for only the most recently unloaded fuel assemblies with the rest being transferred to safely secured dry casks at the earliest date possible.

4.4.3. a Reconfiguring the Spent Fuel Pool

To reduce spent fuel pool vulnerability, the National Academy of Sciences recommended that the fuel pool be rearranged (checker-boarding) so that the recently unloaded, very hot fuel is dispersed in the pool among the older and cooler fuel. *NAS Safety and Security Report, supra* Finding 3C. Shifting the fuel around will yield a small reduction in risk; however it will do no good if there is partial drainage of water or if debris blocks air flow in a drained pool. Dr. Gordon Thompson recommends the pools contain 5-year fuel only and open-frame racks.

4.4.3. b Spray Cooling System

Despite the fact that NRC Chair Nils Diaz and some industry spokespersons, including David Tarantino at Pilgrim, stated April 2005 that fire hoses could be effectively used to extinguish a spent fuel fire, it is unlikely that the resulting high radiation fields would allow human access with hoses. Following an event at the Connecticut Yankee nuclear plant on August 21, 1984, the NRC issued Bulletin 84-03 requiring licensees of operating nuclear plants to among other things calculate the radiation doses in the vicinity of the spent fuel pools should the water level drop. Workers would receive a lethal dose of radiation in 40 to 85 seconds if exposed to the levels that would be present in the area.[43]

The development of a redundant and diverse response system to mitigate loss-of-pool-coolant events is critical. To this end, the National Academy of Sciences recommended also that a spray cooling system be installed and specified that the system must be capable of operation even when the pool is drained (which would result in high radiation fields and limit worker access to the pool) and the pool or overlying building, including equipment attached to the roof or walls, are severely damaged." *NAS Safety and Security Report, supra* at 6 and 57.[44]

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[43] By letter dated November 29, 1984, the licensee of the Connecticut Yankee and Millstone nuclear plants provided the NRC with its response to Bulletin 84-03. The licensee informed the NRC that the calculated radiation dose rate near the edge of a drained spent fuel pool was 40,000 Rem/hr. The dose rate for Millstone Unit 3 was 19,000 Rem/hr. These calculations are representative of the replies received by the NRC from other plant owners. Workers would receive a lethal dose of radiation in 40 to 85 seconds if exposed to such high levels. Twenty years have passed since those calculations and the tons of additional spent fuel have only increased the potential radiation hazards. Given the 25 Rem emergency worker dose limit articulated by the NRC in Information Notice No. 84-40, workers could only visit the area of the spent fuel pool railing for 2-5 seconds, scarcely enough time to position a fire hose and lash it in place.

[44] If water is lost from a spent fuel pool recently discharged fuel can ignite in a period as short as 1-2 hours. The actual period depends on the time since the reactor shutdown for refueling. There is at present no pre-engineered means of spraying water into a drained pool to keep the fuel temperature below the ignition point. Human access with hoses could be precluded by fire or high radiation fields generated as part of the attack, or by other disabling mechanisms such as chemical weapons. Sophisticated attackers might attack the reactor and the pool, using the radiation field from the damaged reactor to preclude access to the pool. Once ignition had occurred, spraying water into the pool would feed the fire through the exothermic steam-zirconium reaction. A massive and probably impractical flow of water would be needed to overcome the effect. (Dr. Gordon Thompson).

4.4.3. c Limiting the frequency of offloads of full reactor cores

An additional precaution to reduce the vulnerability of spent fuel pools would be to limit the frequency of offloads of full reactor cores into the spent fuel pools, requiring longer shut downs of the reactor before any fuel is offloaded, and providing enhanced security when such offloads must be made. *NAS Safety and Security Report, supra* at 59.

4.4.3. d Safer Storage Solutions

The best way to reduce the risk to the public is for the NRC to require low-density pool storage for recently unloaded fuel and secured dry casks for the rest. Petitioners suggest that there are multiple advantages to storing spent fuel in dry casks or low density pools – alternatives that Entergy has not considered at all in its SAMA analysis in its Environmental Report. Among these advantages are: dry cask storage avoids tight packing of thousands of assemblies in the pool, where loss of coolant water/exposure to air would cause them to ignite within a few hours due to the reaction between water, air and immense heat; dry cask storage makes a consequential core accident less likely because the casks are not stored in the reactor building; dry storage is by its nature less dense and therefore minimizes the chance of an accident with thousands of assemblies;[45] there is no risk for dry casks in case of a power outage since waste assemblies cooled by passive air convection; and dry storage has no risk of mechanical breakdowns or problems resulting from human error. The NRC admits dry storage has fewer failure modes and the NRC has approved a range of dry storage designs. Dry storage is in use extensively in the US – at decommissioned plants and at over a dozen operating plants. In fact, no other reactors are building new pools. Low-density pool storage was once a common practice at nuclear plants and poses a lower level of hazard than high-density pool storage. The National Academy of Sciences has also recommended dry cask storage as the best way to reduce the vulnerability of spent fuel pools.

Once the fuel is in casks, the casks must be secured to reduce their vulnerability to attack. In order to protect the dry casks once they are filled on-site, Dr. Gordon

[45] There are generally only 2 dozen assemblies in each dry cask, compared to Pilgrim's pool that has 2,278 today and will have 3,859 by 2012. An accident would result in the release of 10 times more high-level radioactivity than released in Chernobyl – contaminating an area (3) times Massachusetts.

Thompson has outlined two possible schemes for securing them from attack. These are outlined in Exhibit E.

The casks can be multi-purpose, suitable for both storage and shipment. Spent fuel assemblies will have to be put into casks eventually for transport to a permanent repository so the cost of transfer to dry casks will be incurred in the future regardless. Entergy should be required to place the spent fuel in casks now rather than wait until space in its cooling pool completely runs out, because the increased security these casks would provide and the reduction in dense packing in the spent fuel pool would reduce the risk of a severe accident in the pool, and would reduce the consequences of such an accident.

4.4.3. e Costs versus benefits of mitigation alternatives

Although Petitioners do not have the ability to carry out a full cost/benefit analysis of transferring the spent fuel at Pilgrim to dry casks – among other things we do not have access to the MACCS2 inputs used – a rough look at the costs and benefits reveals that this move makes economic sense. Currently casks cost about 1 to 2 million dollars per cask.[46] Pilgrim has approximately 440 tons of fuel on-site which would cost about $71 million dollars to place into dry cask storage. A 1997 study done for the NRC estimated that the median consequences of a spent fuel pool fire at a pressurized water reactor (PWR) that released 8-80 MCi of cesium-137. The consequences included: 54,000-14,000 extra cancer deaths, 2000-7000 km squared of agricultural land condemned, and economic costs due to evacuation of $117-566 billion.[47] In addition, the licensee will incur the costs of moving the fuel out of the pool as it fills anyway, and will

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[46] A BWR fuel assembly contains about 200 kg of uranium. The capital expense to transfer to traditional ISFSI about $120 per kilo uranium/ to transfer to hardened dispersed ISFSI $240 per kilo – Dr. Gordon Thompson, personal communication. Also MIT July 2, 2002 forum-Presentation by Allison MacFarlane.

[47] " . . . shifting fuel to dry cask storage about 5 years after discharge from a reactor, would cost $3.5 -7 billion for dry storage of the approximately 35,000 tons of older spent fuel that would otherwise be stored in U.S. pools in 2010. . . .For comparison, the property losses from the deposition downwind of the cesium-137 released by a spent fuel pool fire would likely be hundreds of billions of dollars. The removal of the older spent fuel to dry storage would therefore be justified by a traditional cost- benefit analysis if the likelihood of a spent fuel fire in the U.S. during the next 30 years were judged to be greater than about a percent." *Reducing the Hazards from Stored Spent Power Reactor, supra* at 3.
Also, *Estimation of Attributable Costs from Plutonium Dispersal Accidents*, D.I Chanin and W.B. Murfin, Sandia National Laboratory, SAND96-095,1996.

ultimately need to put the fuel in dry casks for transfer to a long term repository when one becomes available. As discussed in this contention, the probability of a spent fuel fire increases yearly with the increase in spent fuel densely packed in the pool, and with the risk of ever more sophisticated acts of terrorism increasing. A rough cost/benefit look at moving spent fuel into secured dry cask storage shows that this mitigation makes economic sense. Although in its ER, Entergy has made vague statements about transferring spent fuel assemblies to dry cask storage in the future, it has not outlined how and when this will happen. In a statement to Cape Cod Times, Pilgrim spokesman David Tarantino has stated that Entergy plans to move assemblies out of the spent fuel pools to dry casks only on an as-needed basis, to free up space in the pool for newer spent fuel.[48] This, and the application's silence on the issue of future spent fuel storage, make clear that Entergy has no intention of reconfiguring its pool to low density storage in the future. It also makes it unlikely that the plant will take the initiative to store spent fuel in secured dry cask storage as soon as possible.

4.5 Conclusion

A plant-specific assessment of the vulnerability of the spent fuel pool to fires caused by accident or acts of malice is mandated by the NEPA requirement to consider all of the environmental impacts of the re-licensing. In addition, the NRC Regulations (10 CFR 51.53(c) (ii) (L)) call for consideration of severe accident mitigation alternatives on a plant specific basis if the plant has not already done so. The spent fuel pool, although a Category 1 issue for the purposes of normal operations, should have been included in the Category 2 SAMA analysis of severe accidents in the Applicant's Environmental Report. There is also new information since the Generic Environmental Impact Statement was prepared that demonstrates the spent fuel is likely to remain on-site longer than anticipated, and is more vulnerable to fires than had been known.

As described in Contention 3, it is irrelevant whether Applicant would have decided on mitigation or not. It is the analysis, or "hard look" that is required by NEPA.

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[48] "... and keeping the fuel submerged in cooling waters is just as safe as keeping they in dry casks, Tarantino said. "The plant may have to consider moving spent fuel to dry casks eventually," Tarantino said, "but not the waste that's already there." *What to do with nuclear waste?* Kevin Dennehy, Cape Cod Times, August 15, 2004.

"While NEPA does not require agencies to select particular options, it is intended to 'foster both informed decision-making and informed public participation, and thus to ensure the agency does not act upon incomplete information, only to regret its decision after it is too late to correct' (*citing Louisiana Energy Services* (Claiborne Enrichment Center), CLI-98-3, 47 NRC 77, 88 (1998))." . . . "if 'further analysis' is called for, that in itself is a valid and meaningful remedy under NEPA." *Duke Energy Corp., supra* at13.

The Petitioners have outlined several possible accident scenarios that were not addressed by the Applicant's Environmental Report. In addition, some possible mitigation alternatives have been described. Given the catastrophic impact to human health and the environment if the spent fuel pool experiences loss of water due to accident or terrorist attack, and the benefit that could be achieved at a relatively reasonable cost to the plant operator, mitigation of the existing vulnerability should at least be considered before the license is renewed.

Contention 5: New Information shows that another twenty years of operations at Pilgrim may result in greater off-site radiological impacts on human health than was previously known.

5.0 Contention

New and significant information about cancer rates in the communities around Pilgrim and the demographics of these communities has become available. In addition, new studies show that even low doses of ionizing radiation can be harmful to human health. Epidemiological studies of cancer rates in the communities around Pilgrim show an increase of radiation-linked disease that can be attributed to past operations of the plant. The demographics of the population immediately surrounding the plant, including its age and geographical distribution, make this population more susceptible to radiation-linked damage than was contemplated when the plant was licensed. Pilgrim does not currently have off-site monitoring capabilities that can properly track releases of radiation into the community.

5.1 The Contention is within the Scope of these proceedings

Under 10 CFR 2.309, a petitioner is required to show that the issue raised in the contention is within the scope of the proceeding. The National Environmental Policy Act, NEPA, 42 USC § 4332, is the "basic charter for protection of the environment." 40 CFR § 1500.1(a). Its fundamental purpose is to "help public officials make decisions that are based on understanding of environmental consequences, and take decisions that protect, restore and enhance the environment." 40 CFR § 1500.1(c). The NRC regulations implementing NEPA for Nuclear Plant license renewals are in 10 CFR § 51(c) "Operating license renewal stage." In its application for license renewal of Pilgrim, Entergy was required under 10 CFR § 51 to provide an analysis of the impacts on the environment that will result if it is allowed to continue beyond the initial license. The primary method by which NEPA ensures that its mandate is met is the "action-forcing" requirement for preparation of an EIS. *Robertson v. Methow Valley,* 490 U.S. at 348-49 (1989). The environmental impacts that must be considered in an EIS include those

which are "reasonably foreseeable" and have "catastrophic consequences, even if their probability of occurrence is low." 40 CFR §1502.22(b)(1). The fact that the likelihood of an impact may not be easily quantifiable is not an excuse for failing to address it in an EIS. NRC regulations require that "to the extent that there are important qualitative considerations or factors that cannot be quantified, these considerations or factors will be discussed in qualitative terms." 10 CFR§51.71. The regulation governing licensing renewals requires the Applicant for renewal to submit an Environmental Report. 10 CFR 51.53(c)(1). The NRC then uses the ER to prepare an EIS or Environmental Assessment, although it has an independent obligation to "evaluate and be responsible for the reliability" of the information. 10 CFR §51.70. In a petition for intervention, contentions that seek compliance with NEPA must be based on the applicant's Environmental Report (ER). 10 CFR§2.309(f)(2).

5.2 The issue raised in the Contention is Material to the findings of these proceedings

10 CFR 2.309(f)(iv) requires that the Petitioner "Demonstrate that the issue raised in the contention is material to the findings the NRC must make to support the action that is involved in the proceeding." In discussing the materiality requirement, the Atomic Safety and Licensing Board considering the license renewal for Millstone Nuclear Power Station stated "In order to be admissible, the regulations require that all contentions assert an issue of law or fact that is material to the outcome of a licensing proceeding; that is, the subject matter of the contention must impact the grant or denial of a pending license application. Where a contention alleges a deficiency or error in the application, the deficiency or error must have some independent health and safety significance." *In the Matter of Dominion Nuclear Connecticut, Inc.* (Millstone Nuclear Power Station, Units 2 and 3) Docket Nos. 50-336-LR, 50-423-LR ASLBP No. 04-824-01-LR July 28, 2004, p. 7. See Private Fuel Storage, L.L.C. (Independent Spent Fuel Storage Installation), LBP-98-7, 47 NRC 142, 179-80 (1998), aff'd in part, CLI-98-13, 48 NRC 26 (1998). The deficiency highlighted in this contention has enormous independent health and safety significance. Off-site radiological consequences of operations at nuclear power plants are one of the biggest health and safety concerns of both the industry and the public. If new

and significant information can demonstrate that the Environmental Report needs to take these into account that is material to the findings of these proceedings.

5.3 Basis

Petitioners will be relying on the expert testimony of Richard W. Clapp, DSc, MPH. Dr. Clapp is a Professor of Environmental Health, Boston University School of Public Health. Dr. Clapp founded and served as Director of the Massachusetts Cancer Registry from 1980-1989 and worked in two environmental health consulting groups in addition to his teaching and research activities. He was a consultant to the U.S. EPA Science Advisory Board in its 1995 and 2000 reviews of the dioxin reassessment; and has performed extensive research on health effects from radiation exposure in communities near Pilgrim.

Pilgrim releases radiation as part of its normal operations. This contention presents new and significant information supporting our contention that twenty additional years of operations will be harmful to public health. Radiation-linked diseases are documented in communities around Pilgrim. This fact and projected demographic data indicate that this population will be at an increased risk. The National Academy of Sciences (NAS) latest report on low-dose radiation risk, *Health Risks from Exposure to Low Levels of Ionizing Radiation: BEIR VII Phase 2* (June, 2005) concluded that no amount of radiation is safe. The documented radionuclide releases from Pilgrim in the past have long half-lives and bioaccumulate in the environment. Petitioners submit that if the Applicant disputes a causal link between the radiation released by Pilgrim and the cancers seen in its neighboring towns, the current systems in place to monitor releases are inadequate and should be improved.

5.3.1 The Population Directly Abutting Pilgrim is Increasing Substantially and the Population is Older and thus More Susceptible to Radiation Damage

In this contention, Petitioners will demonstrate that the changing demographics in communities impacted by Pilgrim are such that the dose effect on the population will be far greater than originally anticipated when the plant was licensed.

When Pilgrim was licensed and built in 1972, its location was in an area that was remote and undeveloped. Although sited half-way between Boston and Cape Cod, most vacationers from Boston passed right through Plymouth on the way to more attractive summer resort towns on Cape Cod, Martha's Vineyard and Nantucket. Because of inadequate highway infra-structure, commuting to Boston from this area was not practical. At the project planning stage, the initial site chosen by Boston Edison at the Quincy Naval Air Station was rejected because the area was too heavily populated. The ultimate site in Plymouth was chosen because it was a sparsely populated area.

The population around the plant has changed drastically in the last 30 years, and this aging plant is now located in the fastest growing region in Massachusetts. In Pilgrim's backyard, Pine Hills, the largest housing development in New England, is under construction. The build-out includes 2,877 homes on 3,060 acres, and Pine Hills, Inc. is actively trying to acquire more land to build in this area. The distance from Pilgrim to Pine Hills is < 3 ½ miles. The current Pine Hills household size is 1.95 people per building. Based on these numbers, there will soon be 5, 850 people living just a few miles from this nuclear plant.[49]

In its Environmental Report, Entergy provided a population projection in section 2-16 which showed the population changes and projected changes for all or parts of 15 counties and the cities of Boston, Massachusetts and Providence, Rhode Island. The chart presented the percent annual growth in these regions – a number which minimizes the appearance of the population changes in the immediate area, and as such is misleading. What Entergy did not highlight in its projections is the fact that the region is expected to add 465,000 people by 2030 and this group will be aging with a dramatic

[49] This number does not include transients either visiting or working at Pine Hills.

spike in the over 55 population. The largest population increases are expected in urban centers such as Boston and Cambridge and in a half-dozen suburban towns, such as Plymouth and Weymouth which have very large housing developments on the horizon. *The Boston Metropolitan Area Planning Council Report on Population and Employment Projections 2010 -2030*, http://www.mapc.org/2006 projections.html. The methodology used by MAPC is described in the report. (see Exhibit F-1). According to the report the area south of Boston is expected to grow faster in population and jobs than any other section of Greater Boston through the year 2030. Communities south of Boston will grow 13% and Plymouth is expected to add the most, about 10,000 residents – a population jump of over 20%. By 2030, 1 in 3 people will be over the age of 55, compared to 1 in 5 now. This is relevant to any analysis of health impacts, as studies have shown an increased sensitivity to low levels of ionizing radiation in older populations. *Greater Sensitivity to Ionizing Radiation At Older Age: follow-up of workers at Oak Ridge National Laboratory through 1990.* Richardson, D.B. and Wing, S. Int. J. Epidemiol., 1999, 28:428-436; *The Hanford Data: Issues of Age at Exposure and Dose.* Stewart, A.M., Kneale, G.W., PSR Quarterly Vol. 3, No.3 (Sept. 1993) 3:101-111; and *Leukaemia near nuclear power plant in Massachusetts*, Richard Clapp, Sidney Cobb, C K Chan, Bailus Walker, 924 , Lancet, 1987.

5.3.2 Radioactive Emissions from Pilgrim

When an EIS is prepared, NEPA requires the NRC to "disclose the significant health, socioeconomic and cumulative consequences of the environmental impact of a proposed action." The CEQ defines cumulative impacts as: "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time." *Baltimore Gas and Electric Co. v. Natural Resources Defense Council*, 462 U.S. 87, 106-7 (1983), citing Council on Environmental Quality ("CEQ") regulations at 40 CFR §§1508.7 and 1508.8.

In its Final Environmental Impact Statement, the 1972 owners of Pilgrim stated in the Summary of Environmental Impacts and Effects, Section 5-c. that, "The effluents from the facility, if operated as described by the Applicant and in accordance with the technical specifications and rules and regulations of the Commission, will not endanger the public health or the natural environs of the station." *Final Environemtal Imapct Statement, Pilgrim Nuclear Power Station,* Boston Edison Company, Docket 50-293, 5-c, p. iii, US Atomic Energy Commission Division of Radiological and Environmental Protection, (May 1972). In its current Application, Appendix E, Applicant states "Very low levels of radioactivity may be released in plant effluents if they meet the limits specified in NRC's regulations. These releases are closely monitored and evaluated for compliance with the NRC restrictions in accordance with the PNPS Offsite Dose Calculation Manual." ER Appendix E.3.2.3.1. Essentially the same was stated regarding solid and gaseous releases. Therefore the assumption is that there will be no danger to public health from routine releases since they will be monitored and will not exceed federal limits.[50] However, despite this confidence written into the Application, Petitioners bring forward new and significant information that demonstrates that there has ***already*** been documented radiation linked disease in the communities near PNPS. In addition, a recent report was published by the National Academy of Sciences that demonstrates that ***there is no safe dose of radiation for humans.***

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[50] "The NRC, in 10CFR 20.1301 (Reference 8) limits the levels of radiation to unrestricted areas resulting from the possession or use of radioactive materials such that they limit any individual to a dose of: less than or equal to 100 mrem per year to the total body. In addition to this dose limit, the NRC has established design objectives for nuclear plant licensees. Conformance to these guidelines ensures that nuclear power reactor effluents are maintained as far below the legal limits as is reasonably achievable. The NRC, in 10CFR 50 Appendix I (Reference 9) establishes design objectives for the dose to a member of the general public from radioactive material in liquid effluents released to unrestricted areas to be limited to: * less than or equal to 3 mrem per year to the total body; and, * less than or equal to 10 mrem per year to any organ. The air dose due to release of noble gases in gaseous effluents is restricted to:* less than or equal to 10 mrad per year for gamma radiation; and, * less than or equal to 20 mrad per year for beta radiation.The dose to a member of the general public from iodine-131, tritium, and all particulate radionuclides with half-lives greater than 8 days in gaseous effluents is limited to:* less than or equal to 15 mrem per year to any organ. The EPA, in 40CFR190.10 Subpart B (Reference 10), sets forth the environmental standards for the uranium fuel cycle. During normal operation, the annual dose to any member of the public from the entire uranium fuel cycle shall be limited to:* less than or equal to 25 mrem per year to the total body; * less than or equal to 75 mrem per year to the thyroid; and, * less than or equal to 25 mrem per year to any other organ." *Pilgrim Nuclear Power Station Radiological Environmental Monitoring Program Report,* p.20 (2004).

5.3.3 Radiation-Linked Diseases in Communities near Pilgrim

There is new information since Pilgrim began operations in 1972 that shows increases in radiation-linked diseases in the communities around Pilgrim. The increases were in part attributed to operating with defective fuel; operating without the off-gas treatment system in the first years; poor management and practices culminating in the releases in June 1982 that coincided with weather conditions that held the releases over the area. *Southeastern Massachusetts Health Study 1978-1986,* Morris, Martha and Knorr, Robert, Commonwaelth of Massachusetts Executive office of human Sevices, Department of Public health, 1990 and *Meteorological Analysis of Radiation Releases For the Coastal Areas of The State of Massachusetts For June 3rd to June 20th, 1982,* William T. Land.

The cancers found in the communities around the power station were studied by Dr. Sidney Cobb and Dr. Richard Clapp and their results were published in a peer reviewed journal in 1987. They included elevated rates of Myelogenous Leukemia – a type of cancer most likely to be triggered by exposure to radiation.[51] This led to a case-control study carried out by the Massachusetts Department of Public Health that showed a four fold increase in adult Leukemia between 1978 and 1983. The report stated "a dose-response relationship was observed in that the relative risk of leukemia increased as the potential for exposure to plant emissions also increased."[52]

Evidence of radiation-linked disease continued. In a statement before the Southeastern Massachusetts Health Study Review Committee [June 26, 1992] Dr.

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[51] An epidemiological analysis of five towns around Pilgrim shows a 60 percent increase in leukemia rate, excluding leukemias not caused by radiation exposure. - Dr. Sidney Cobb, et.al., Lancet, 1987. The rate of myelogenous leukemia (the type most likely to be triggered by exposure to radiation) among males in the 5 towns around the Pilgrim reactor was found to be 2 1/2 times greater than the statewide average. *Leukemia in Five Massachusetts Coastal Towns,* Dr. Sydney Cobb, et al., Abstract for the American Epidemiologic Society, March 18, 1987; and *Leukemia near Massachusetts Nuclear Power Plant,* letter, Clapp, R.W., Cobb, S, Chan, C.K., Walker, B., Lancet 1987; 2:1324-5.

[52] Adults living and working within ten miles of the Pilgrim reactor had a fourfold increased risk of contracting leukemia between the years of 1978 and 1983 when compared with people living more than 20 miles away, according to a 1990 study by the Massachusetts Department of Public Health. *Southeastern Massachusetts Health Study 1978-1986,* Morris, M.S., Knorr, R.S., Massachusetts Department of Health, Southeastern Massachusetts Health Study, Oct., 1990. Archives of Environmental Health, Vol. 51, p266, 1996, July-Aug. #4.

Richard W. Clapp, the founder and former director of the Massachusetts Cancer Registry, presented a graphical assessment of the pattern of leukemia and thyroid cancer in the towns closest to Pilgrim during the period 1982-1989. *Analysis of 1974-1989 Massachusetts Cancer Registry for Leukemia & Thyroid Cancer*, Dr. Richard Clapp, DSc, MPH (2006), *personal communication.* Exhibit F-4 shows graphs of the incidence leukemia and thyroid cancer in the Plymouth area. The incidence of leukemia peaked in 1982 and subsequently declined until 1986. Then there was a second, smaller peak in 1987 and 1988 while declined in 1989. The number of cases exceeded the number expected in 1982-85 and 1987-88. The second graph depicts the pattern of thyroid cancer in the same set of towns. It shows a peak in the years 1987-1988. These patterns of cancer incidence are consistent with the predicted health effects of the radiation released in the early 1980s. A graph showing the predicted health effects is also shown in Exhibit F. A statistically significant increase in childhood leukemia was noted in communities near Pilgrim, too. Although Massachusetts Department of Public Health recommended a state sponsored case controlled childhood leukemia study, it was not done.

The Massachusetts Cancer Registry also shows, for the years 1998-2002, a continuing increase of leukemia and thyroid cancer in the towns around PNPS. Specifically, there were 83 cases of leukemia reported to the Massachusetts Cancer Registry (MCR), where 72.9 would have been expected based on statewide rates. This results in a Standardized Incidence Ratio (SIR) of 114 (95% conf. int. = 91-143). In addition, there was excess thyroid cancer in these same towns for the same time period. The thyroid cancer SIR was 122 (95% conf. int. = 96-155). In other words, leukemia was 14% elevated over the statewide rate and thyroid cancer was 22% elevated. Neither of these calculations were statistically significantly elevated by the usual convention ($P<.05$), but there were more cases than expected nevertheless. This means there is a continuing excess of these two radiation-related cancers in the population, as there was in the 1980s. *Analysis of 1998-2002 Massachusetts Cancer Registry for Leukemia & Thyroid Cancer,* Dr. Richard Clapp, 2006, *personal communication.*

Prostate cancer and multiple myeloma, both radiation-linked diseases, are also elevated and statistically significant for the years 1998-2002 in the seven towns most likely to be impacted near Pilgrim (Carver, Duxbury, Kingston, Marshfield, Pembroke,

Plymouth, and Plympton). *Health Risks from Exposure to Low Levels of Ionizing Radiation: BEIR VII Phase 2 (2006).* Occupational Radiation Studies, Chapter 8,, National Academies Press, 2006.Specifically, data from the Massachusetts Cancer Registry indicates 613 cases of prostate cancer vs. 513.5 expected, SIR=119 (95% C.I.=110-129); multiple myeloma: 47 cases vs. 31.7 expected, SIR=148 (95% C.I.=108-198). *Analysis of 1998-2002 Massachusetts Cancer Registry for Leukemia & Thyroid Cancer*, Dr. Richard Clapp, 2006, *personal communication.*

5.3.4 BEIR Vll: Health Effects of Low Level Ionizing Radiation

The National Academies Committee to Assess Health Risks from Exposure to Low Levels of Ionizing Radiation, the National Research Council, published *Health Risks from Exposure to Low Levels of Ionizing Radiation: BEIR VII Phase 2* in 2005. Drawing upon new data in both epidemiologic and experimental research, they concluded that no amount of radiation is safe. There is a linear no threshold response to radiation, and exposure to low levels of radiation is approximately three-times more dangerous than previously thought. *BEIR VII: Health Risks from Exposure to Low Levels of Ionizing Radiation*, Report in Brief, June 2005. Therefore it is not surprising that radiation-linked disease rates are higher than expected in communities exposed to Pilgrim's past releases.

A summary of cancer deaths estimated at NRC's permissible dose release is provided in the BEIR VII Report. The report shows the number of cancer cases and deaths expected to result in 100,000 persons (with an age distribution similar to that of the entire U.S. population) exposed to 100mSv per year over a 70 year lifetime. On average, assuming a sex and age distribution similar to that of the entire U.S. population, the BEIR VII lifetime risk model predicts approximately one individual in 100 persons would be expected to develop cancer (solid cancer or leukemia) and approximately one in 175 would be expected to die from cancer from a the permissible dose of 100 mSv. Lower doses would produce proportionately lower risks. For example one in 1000 would develop cancer from an exposure to 10 mSv.

This new report validates concerns raised by Petitioners and helps explain the radiation-linked disease observed near Pilgrim NPS. When the standards were set by the NRC for permissible release of off-site radiation, low levels of radiation were considered harmless. However, the BEIR VII report now reveals that any exposure is potentially dangerous. Therefore it is not surprising that radiation-linked disease rates are higher than expected in communities exposed to Pilgrim's past radiological releases.

This new information is particularly relevant to the issue of re-licensing Pilgrim because twenty additional years of exposure will harm an already damaged population. Both BEIR VII and previous nuclear worker studies show that the health effects of radiation are cumulative. *Effects of Radiation and Chemical Exposures on Cancer Mortality Among Rocketdyne Workers: A Review of Three Cohort Studies.* Morgenstern, H and Ritz, B., Journal: *Occupational Medicine: State of the Art Reviews,* Vol. 16, No. 2, April-June 2001, pages 219-238. And as shown previously, there is a growing and aging population in the area immediately surrounding the plant. This population has already been harmed by the effects of radiation from Pilgrim and as a result is more susceptible to even permissible levels of off-site radiation. An additional twenty years of operations would put a group that is already damaged at further risk.

5.3.5 Bio-Accumulation of Radionuclides in the Environment from 1972-2032

The effects of radiation exposure are cumulative. Some types of nuclear power plant emissions stay radioactive for a long time and, because they can enter biological food chains, those materials can accumulate in the environment and adversely affect public health. "If radioactive emissions persist for years, decades or even centuries within the environment, then even modest reductions in annual discharges may not be sufficient to prevent an environmental build up of those materials over time." *Estimates of Environmental Accumulations of radioactivity Resulting from Routine Operation of New England Nuclear Power Plants (1973-84),* Dr. Richard W. England,, Mr. Eric Mitchell, p.4, A Report of the Nuclear Emission Research Project, Whittemore School of Business and Economics, University of New Hampshire, Durham, N.H., August 1987.

It is known for example that the following radionuclides have been released from Pilgrim into neighboring communities: plutonium 239 (half life 24,400 years);

neptunium 236 or 237 (half life ranging from 120,000years -2.1 million years); cesium 137 (half life 30.2 years); strontium 90 (half life 28.5 years); tritium (half life 12.3 years), and xenon (half life 9.17 hours). Xenon transforms after its emission into cesium 135, which persists almost indefinitely in the environment. Examples of previous releases have been reported in the Annual Radiological Environmental Monitoring Program Reports [REMP].[53] These releases include substances that will remain active in the local environment for the foreseeable future and should be taken into account when actual on-going doses to the public are evaluated.

5.3.6 Pilgrim has operated, and most likely will continue to operate with defective fuel

Pilgrim began operations in 1972 with defective fuel. The Massachusetts Department of Public Health's Southeastern Massachusetts Health Study 1978-1986 stated, "Pilgrim, which began operations in 1972, had a history of emissions during the 1970s that were above currently acceptable EPA guidelines as a result of a fuel rod problem." *Southeastern Massachusetts Health Study 1978-1986*, Morris M.S., Knorr R.S., Executive Summary, Massachusetts Department of Health (October, 1990).

In the March 2005 and April 2006 Pilgrim SALP (Systematic Assessment of License Performance, performed by the NRC) Reports, NRC Resident Inspector, William Raymond, stated that Pilgrim operated in 2004 and 2005 with defective radioactive fuel – that is, fuel with perforated cladding. Fuel cladding provides the first barrier to prevent radiation from getting out and harming workers and the public. Degraded fuel is an on going issue for the industry. NRC Commissioner Merrifield has admitted nearly 1/3 reactors now have failed fuel, and the trend is increasing, not decreasing. *Briefing on Nuclear Fuel Performance,* Transcript, p.4, (February 24, 2005), http://www.nrc.gov.

[53] For example, in June 1982, Pilgrim blew its filters and released contaminated resin material off site into surrounding communities. The licensee's own Radiological Environmental Monitoring Program Report for 1982 showed for example: Cesium -137, (1,000,000) times higher than expected in milk tested at the indicator sampling farm 12 miles west of the reactor and no elevation at the control station, 22 miles away; Cesium-137 again (1,000,000) higher in vegetation samples from indicator farms .7 miles and 1.5 miles from the reactor. Plutonium 239/240: Radiological Environmental Reports(REMP) 1998, Plutonium found in indictor samples and Duxbury Beach; REMP 1999, Plutonium found Duxbury Beach; REMP 2000, Plutonium in indicator samples and Duxbury Beach, later excused by stating contamination must have resulted from a dirty beaker; REMP 2001 Plutonium Duxbury Beach; REMP 2003 forward stopped testing for Plutonium on Duxbury Beach.

Use of degraded fuel will increase exposure to both the public and workers. For example, according to the NRC, "a plant operating with 0.125 percent pin-hole fuel cladding defects showed a general five-fold increase in whole-body radiation exposure rates in some areas of the plant when compared to a sister plant with high-integrity fuel (<0.01 percent leaks). Around certain plant systems the degraded fuel may elevate radiation exposure rates even more." United States Nuclear Regulatory Commission, Information Notice No. 87-39, *Control Of Hot Particle Contamination At Nuclear plants*, (August 21, 1987).

5.3.7 Monitoring Radioactive Emissions

The Petitioners would like to submit that if Applicant disputes a causal link between the radiation released by Pilgrim and the cancers seen in its neighboring towns, the current systems in place to monitor releases are inadequate and should be improved. The Comments to the Southeastern Massachusetts Leukemia Study made by Dr. Richard Clapp illustrate this point:

> "I would like to reiterate a point that Drs. Knorr and Morris [Massachusetts Department of Public Health epidemiologists, authors of the Southeastern Massachusetts Health Study] made to you in one of their memoranda, e.g., that the emissions data provided by the utility are not reliable. I have had numerous discussions with individuals in the Department of Public health as well as colleagues who previously worked in a job monitoring worker exposure to Pilgrim contractors in the mid-1970's. From these discussions, I am convinced that the actual emissions were considerably worse than what has appeared in public documents and has been available to researchers to date. In particular, there were transuranic isotopes[54]released that should never have been emitted to the general environment." Richard C. Clapp, MPH,Sc,D., Statement before the Southeastern Massachusetts health Study Review Committee, (June 26, 1992)

In the years since that statement was made, the quality of the environmental monitoring by Pilgrim has, if anything, decreased. (see Exhibit F-4). Petitioners can not be required to prove a causal link between the radiation released and the statistically

[54] The transuranic isotope referred to was Neptunium. Neptunium releases were reported orally to Dr. Clapp by Stuart Shalat, who worked for the contractor doing the re-fueling in the 1980s.

significant increase in cancers if there is no effective monitoring system in place to measure those releases nor can the Applicant claim that a causal link does not exist.

As stated previously, it is the assertion of Petitioners that the system in place to monitor off-site radiological releases at Pilgrim is inadequate. Although there are documented increases in radiation-linked cancers in the communities around the plant, this aging plant does not use monitors which would allow state or federal authorities to confidently measure radiation releases. Some of the deficiencies of the monitoring system currently used by Pilgrim are described in Exhibit C, as well as suggested improvements that could be made to the Pilgrim environmental monitoring program.

5.4 Conclusion

Petitioners have presented new and significant information that shows that the off-site radiological consequences of another twenty years of operations by Pilgrim may be greater than previously thought. Epidemiological studies of cancer rates in the communities around Pilgrim show an increase of radiation-linked disease that can be attributed to past operations of the plant. The demographics of the population immediately surrounding the plant, including its age and geographical distribution, make this population more susceptible to more radiation-linked damage than was contemplated when the plant was licensed. Finally, Petitioners propose an improved monitoring system which would allow the effects of off-site radiation on neighboring communities to be reliably and accurately assessed during operations and decommissioning.

Respectfully submitted,

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May 25, 2006

EXHIBITS

Exhibit A - Contaminated Water Leakage

Exhibit B – Corrosion in Drywell Liner

Exhibit C – Monitoring

Exhibit D – Economic Impact Tourism

Exhibit E - Dry Cask Storage

Exhibit F - Health

EXHIBIT A

Contaminated Water Leakage

A-1. Union of Concerned Scientists et al, Petition Pursuant to 10 CFR 2.206 - Enforcement Action - Longstanding Leakage of Contaminated Water, Appendix A, January 25, 2006

A-2. NRC Preliminary Notification of Event Or Unusual Occurrence – PNP-III-06-004B, Byron NPS, April 20, 2006

A-3. NRC Event Number 42381, Palo Verde, NRC: Event Notification Report for March 3, 2006

EXHIBIT A -1

Contaminated Water Leakage

Union of Concerned Scientists et al, Petition Pursuant to 10 CFR 2.206 - Enforcement Action - Longstanding Leakage of Contaminated Water, Appendix A, January 25, 2006

Appendix A:
Contaminated Water Leakage Event Summaries

This appendix summarizes seven events within the past decade involving leakage of contaminated water into the ground around a U.S. nuclear facility. The frequency of leakage events is increasing – three (3) of the events were reported last year. In addition, the magnitude of the events is also increasing. It appears that the amount of contaminated water leaked into the ground during the most recently reported event exceeds the total amount of leakage from all six prior events. In addition, this most recent event involved migration of the contaminated water to offsite areas.

Braidwood – Contaminated water leakage from underground piping
On December 6, 2005, the NRC was informed that workers had detected low levels of tritium in a drinking water well at a home near the Braidwood nuclear plant in Illinois. Preliminary sampling results indicated a tritium level of 1,150 picocuries per liter, below the EPA drinking water standard of 20,000 picocuries per liter. The sampling of offsite wells occurred after results from monitoring wells on the Braidwood site indicated tritium levels up to 58,000 picocuries per liter. The highest level from an offsite monitoring well has been 34,000 picocuries per liter. The "*initial evaluation indicated that the tritium in the groundwater was a result of past leakage from a pipe which carries normally non-radioactive circulating water discharge to the Kankakee River, about five miles from the site. Several millions* [sic] *gallons of water leaked from the discharge pipe in 1998 and 2000. The pipe is also used for planned liquid radioactive effluent releases with the effluent mixing with the circulating water being discharged.*"[1]

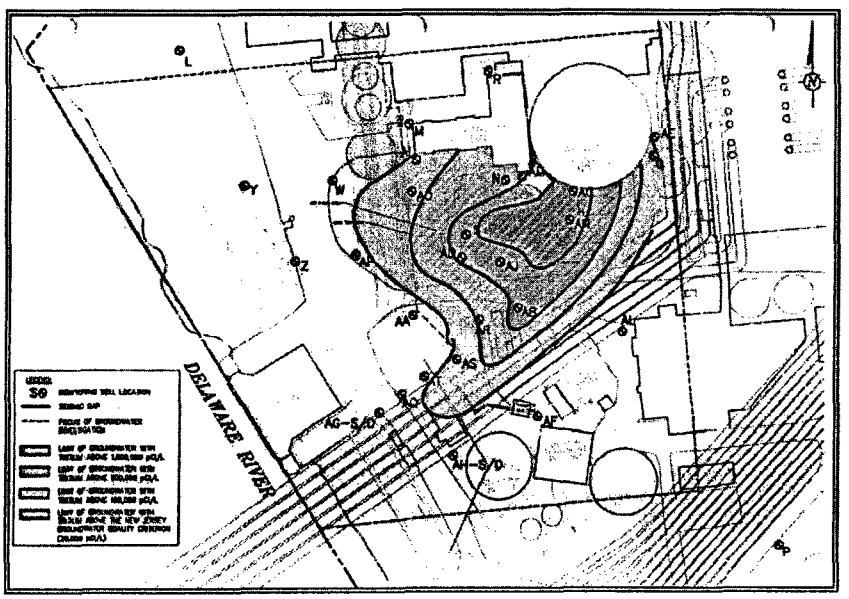
Haddam Neck – Contaminated water leaking from spent fuel pool
On October 31, 2005, the NRC was informed that workers detected evidence that the spent fuel pool at the Haddam Neck nuclear plant in Connecticut was leaking into the ground. The rate of leakage was unknown but estimated to be on the order of a few gallons per day. Monitoring wells down gradient from the leakage site did not indicate the groundwater plume had traveled past the plant site.[2]

Indian Point – Contaminated water leakage from the Unit 2 spent fuel pool
On September 1, 2005, the NRC was informed that workers excavating ground around the Unit 2 Fuel Handling Building at the Indian Point nuclear power plant in New York found water seeping from cracks in the concrete wall of the building. Chemical analysis of the water determined its source to be the Unit 2 spent fuel pool. On October 5, 2005, tritium was detected in a monitoring well on the plant site.[3]

Dresden – Contaminated water leakage from underground piping
On August 30, 2004, the owner of the Dresden nuclear power plant in Illinois determined that tritium levels in monitoring wells indicated that contaminated water might be leaking into the plant's grounds. Further investigation identified the source of the leak as being an underground section of piping that carried "*water with a higher-than-normal level of tritium.*" According to utility responses the leakage of 267,000 gallons contaminated the ground with tritium originally described as localized "*roughly in a 30-foot area around the leak*" included multiple storm drains, some of which communicated offsite through the station's discharge canal to the river. According to an Illinois EPA document onsite radiation readings reported tritium levels up to 10,312,000 picocuries per liter. The owner replaced that section of piping by December 2004.[4]

Salem – Contaminated water leakage from the Unit 1 spent fuel pool
On September 18, 2002, workers inside the Auxiliary Building of the Unit 1 reactor at the Salem nuclear power plant in New Jersey had radioactivity detected on their shoes. Investigation into the source of radioactivity picked up on their shoes found water on the flow of a room inside the Auxiliary Building. Chemical analysis of this water pinpointed the spent fuel pool as its likely source. The Unit 1 spent fuel pool has a reinforced concrete floor and walls that are lined with stainless steel. Leakage of groundwater

in through the concrete and leakage of spent fuel pool water out through the liner was routed through drainage piping to a system that collected and processed contaminated liquids. On January 31, 2003, workers conducted a fiber optic examination of the drainage piping and discovered that it was blocked with precipitates, allowing water to accumulate in the space between the concrete and the liner. When the blockage was removed, the measured flow through the drainage piping was 100 gallons per day. During the period that the drainage piping was blocked, spent fuel pool water leaked through the concrete into the grounds surrounding the plant. Workers confirmed this fact with eight monitoring wells installed adjacent to the Unit 1 Fuel Handling Building in January and February 2003. The groundwater contained tritium concentrations "above the New Jersey Groundwater Quality Criterion of 20,000 pCi/L [picocuries per liter]."[5] A consultant retained to investigate the matter concluded: *"The testing results indicate that build-up of SFP* [spent fuel pool] *water behind the liner has been ongoing for at least five years."*[6] The plant owner undertook an extensive groundwater remediation effort to reduce tritium concentrations below the New Jersey criterion.



BWX Technologies, Inc – Contaminated water leakage from cask handling area pool

On September 19, 2000, workers at the BWX Technologies facility in Lynchburg, Virginia determined that the cask handling area pool was leaking approximately 250 gallons per day into the ground. The pool was approximately 528 yards from the James River. The pool contained irradiated reactor hardware and several spent fuel rods. The radionuclide concentrations of the water in this pool were significantly above the concentrations allowed by 10 CFR Part 20 for releases to unrestricted areas. Boroscopic examination identified cracks across the transfer cavity region of the pool. The estimated radiation dose to a member of the public drinking water from the James River was calculated to be less than one millirem per year.[7]

Brookhaven National Laboratory – Contaminated leakage from spent fuel pool[4]

In January 1997, workers detected tritium levels in groundwater samples at twice the EPA drinking water standard. Subsequent investigations found samples reading 32 times higher than the EPA standard and that *"The tritium was found to be leaking from the laboratory's High Flux Beam Reactor's spent-fuel pool into the aquifer that provides drinking water for nearby Suffolk County residents."* DOE's investigation concluded that the leak, estimated to be 6 to 9 gallons per day, had been occurring for as long as 12 years. On May 16, 1997, the DOE informed the contractor responsible for operating the Brookhaven National Laboratory that its contract was being terminated due to performance problems associated with the longstanding tritium leak.[8]

[4] Unlike all of the other cases, this case does not involve an NRC licensee. The Brookhaven National Laboratory was regulated by the U.S. Department of Energy. This event is included nonetheless because what happened at Brookhaven can happen, and has happened, at NRC-licensed sites and can have similar consequences.

EXHIBIT A -2

Contaminated Water Leakage

NRC Preliminary Notification of Event Or Unusual Occurrence – PNP-III-06-004B, Byron NPS, April 20, 2006

April 20, 2006

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE – PNO-III-06-004B

This preliminary notification constitutes EARLY notice of events of POSSIBLE safety or public interest significance. The information is as initially received without verification or evaluation, and is basically all that is known by the Region III staff on this date.

Facility		Licensee Emergency Classification
Facility Name	Byron Units 1 and 2	___Notification of Unusual Event
Licensee	Exelon Generating, LLC	___Alert
City, State	Byron, IL	___Site Area Emergency
Docket:	50-454 and 50-455	___General Emergency
License:	NPF-37 and NPF-66	_X_ Not Applicable

SUBJECT: RESUMPTION OF EFFLUENT DISCHARGES

DESCRIPTION:

Exelon notified the NRC Region III (Chicago) that it was planning to resume normal, radioactive effluent discharges at the Byron Nuclear Generating Station through the blowdown line to the Rock River beginning on April 20, 2006. Following the licensee's identification of past leakage from the system, the licensee implemented corrective actions that included inspection and maintenance of the vacuum breakers, groundwater monitoring, and sealing of the vacuum breaker vaults. The licensee has also implemented additional measures to prevent, detect, and mitigate any potential system leakage. The NRC has inspected the licensee's actions and confirmed that these actions provide adequate confidence that the system will operate appropriately. Exelon is planning to issue a press release prior to commencing the effluent discharge.

Background Information:

On February 10, 2006, Exelon informed the resident inspectors and Region III that elevated levels of tritium in water had been identified in several vacuum breaker vaults located along the Byron discharge piping. This piping is on plant property. The piping is approximately 2.5 miles long normally carrying non-radioactive circulating water to the Rock River. The discharge pipe is also used for planned liquid radioactive effluent releases with effluent mixing with the discharge water.

Exelon installed additional monitoring wells to fully characterize the extent of contamination and to inspect the pipeline for leaks.

The licensee had suspended releases of radioactive effluents in February 2006 and was storing liquid effluents in existing plant equipment at the Byron site.

On March 31, 2006, Exelon notified the NRC Region III (Chicago) that its monitoring program at the Byron Nuclear Generating Station identified slightly elevated concentrations of tritium in groundwater on company property close to the Byron circulating water blowdown piping. Based on earlier sample results taken from within the six vacuum breaker vaults, the licensee installed ground water monitoring wells near the six vacuum breaker vaults along the station's discharge pipe to allow further sampling for tritium. Wells beside four of the six vaults showed no detectable levels of tritium. Test wells beside the other two showed low levels of tritium. One showed a concentration of about 3800 picocuries per liter, the other about 450 picocuries per liter.

The State of Illinois has been informed of this updated information. The information in this preliminary notification has been reviewed with licensee management. This information is current as of 11:00 a.m. Central Time on April 20, 2006.

CONTACTS:

Bruce Bartlett	Rick Skokowski	Steven Orth
815-234-5451	630-829-9620	630-829-9827

EXHIBIT A -3

Contaminated Water Leakage

NRC Event Number 42381, Palo Verde, NRC: Event Notification Report for March 3, 2006

Power Reactor	Event Number: 42381
Facility: PALO VERDE Region: 4 State: AZ Unit: [ ] [ ] [3] RX Type: [1] CE,[2] CE,[3] CE NRC Notified By: DAN MARKS HQ OPS Officer: BILL GOTT	Notification Date: 03/02/2006 Notification Time: 18:48 [ET] Event Date: 03/02/2006 Event Time: 14:30 [MST] Last Update Date: 03/02/2006
Emergency Class: NON EMERGENCY 10 CFR Section: 50.72(b)(2)(xi) - OFFSITE NOTIFICATION	Person (Organization): JACK WHITTEN (R4)

Unit	SCRAM Code	RX CRIT	Initial PWR	Initial RX Mode	Current PWR	Current RX Mode
3	N	Y	100	Power Operation	100	Power Operation

Event Text OFFSITE NOTIFICATION

"The following event description is based on information currently available. If through subsequent reviews of this event, additional information is identified that is pertinent to this event or alters the information being provided at this time, a follow-up notification will be made via the ENS.

"This is a report of a situation, related to the protection of the environment, for which a notification to another government agency has been or will be made, as described in 10CFR50.72(b)(2)(xi).

"Specifically, the Palo Verde Nuclear Generating Station (PVNGS) notified the Arizona Department of Environmental Quality (ADEQ) of the possibility of a discharge of non-hazardous material that has the potential to cause groundwater limits to be exceeded

"At Palo Verde Unit 3, water was observed in a concrete pipe vault that was abutted against soil. The source of the water appeared to becoming from seals around the pipes and originating from the ground behind the pipe chase. The area behind the pipe chase contains a series of pipes buried in a layer of compacted soil. In order to characterize the water and identify its source, a pothole, approximately 13 feet deep and reinforced with a perforated drain pipe was dug in the radiological controlled area yard so that a sample of the water could be obtained. Initial results from the unit laboratory indicated the presence of tritium. A confirmatory sample was collected and analyzed by the State certified laboratory at Palo Verde that confirmed the presence of tritium at a concentration of approximately 7.14 x 10 -5 microCurie per milliliter. The Aquifer Protection Permit Aquifer Quality Limit for tritium is 2.00 x 10 -5 microCurie per milliliter.

"At this time we are working to identify the source. We currently have no evidence that the water has contaminated any aquifer but are continuing with our investigation. Palo Verde's ground-water monitoring program - in place since the unit operations began - has validated that no tritium has been present in any wells or aquifers in any quarterly samples. PVNGS has just finished collecting its quarterly monitoring samples. Analyzed samples have no indication of tritium. The remaining samples will be completed next week.

"No Technical Specification effluent limits have been exceeded. No Offsite Dose Calculation Manual (ODCM) effluent limits have been exceeded. No federal effluent limits have been exceeded. Palo Verde has not identified any health or safety risk to the public or onsite personnel.

"No source of leakage or release path has been identified, therefore no release rate or total quantity released has been quantified.

"Unit 3 is operating at approximately 100% rated thermal power at normal operating temperature and pressure.

"This information is also being reported to the Arizona Radiation Regulatory Agency."

The licensee notified the NRC Resident Inspector.

EXHIBIT B

CORROSION IN DRYWELL LINER

NUCLEAR REGULATORY COMMISSION, Proposed License Renewal Interim Staff Guidance LR-ISG-2006-01: Plant-Specific Aging Management Program for Inaccessible Areas of Boiling Water Reactor Mark I Steel Containment Drywell Shell Solicitation of Public Comment, Federal Register: May 9, 2006 (Volume 71, Number 89)] [Notices] [Page 27010-27012]

EXHIBIT B – DRYWELL LINER

Federal Register: May 9, 2006 (Volume 71, Number 89)] [Notices] [Page 27010-27012]

NUCLEAR REGULATORY COMMISSION: Proposed License Renewal Interim Staff Guidance LR-ISG-2006-01: Plant-Specific Aging Management Program for Inaccessible Areas of Boiling Water Reactor Mark I Steel Containment Drywell Shell -Solicitation of Public Comment

SUMMARY: The Nuclear Regulatory Commission (NRC) is soliciting public comment on its Proposed License Renewal Interim Staff Guidance LR-ISG-2006-01. This LR-ISG proposes that applicants for license renewal for a plant with a boiling water reactor Mark I steel containment provide a plant-specific aging management program that addresses the potential loss of material due to corrosion in the inaccessible areas of their Mark I steel containment drywell shell for the period of extended operation.

The NRC staff issues LR-ISGs to facilitate timely implementation of the license renewal rule and to review activities associated with a license renewal application (LRA). Upon receiving public comments, the NRC staff will evaluate the comments and make a determination to incorporate the comments, as appropriate. Once the NRC staff completes the LR-ISG, it will issue the LR-ISG for NRC and industry use. The NRC staff will also incorporate the approved LR-ISG into the next [[Page 27011]] revision of the license renewal guidance documents.

DATES: Comments may be submitted by June 8, 2006.

FOR FURTHER INFORMATION CONTACT: Ms. Linh Tran, License Renewal Project Manager, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001; telephone 301-415-4103 or e-mail lnt@nrc.gov.

SUPPLEMENTARY INFORMATION: Attachment 1 to this Federal Register notice, entitled Staff Position and Rationale for the Proposed License Renewal Interim Staff Guidance LR-ISG-2006-01: Plant-specific Aging Management Program for Inaccessible Areas of Boiling Water Reactor Mark I Steel Containment Drywell Shell contains the NRC staff's rationale for publishing the proposed LR-ISG-2006-01. Attachment 2 to this Federal Register notice, entitled Proposed License Renewal Interim Staff Guidance LR-ISG-2006-01: Plant-specific Aging Management Program for Inaccessible Areas of Boiling Water Reactor Mark I Steel Containment Drywell Shell, contains the guidance for developing the

plant-specific aging management program. The NRC staff is issuing this notice to solicit public comments on the proposed LR-ISG-2006-01. After the NRC staff considers any public comments, it will make a determination regarding the proposed LR-ISG.

Dated at Rockville, Maryland, this 3rd day of May 2006.

For the Nuclear Regulatory Commission., Pao-Tsin Kuo, eputy Director, Division of License Renewal, Office of Nuclear Reactor Regulation.

Attachment 1--Staff Position and Rationale for the Proposed License Renewal Interim Staff Guidance LR-ISG-2006-01: Plant-Specific Aging Management Program for Inaccessible Areas of Boiling Water Reactor Mark I Steel Containment Drywell Shell

Staff Position: The NRC staff determined that applicants for license renewal for a plant with a boiling water reactor Mark I steel containment should provide a plant-specific aging management program (AMP) that addresses the potential loss of material due to corrosion in the inaccessible areas of the Mark I steel containment drywell shell for the period of extended operation.

Rationale: The current license renewal guidance documents (LRGDs) do not provide sufficient guidance to address inaccessible areas of the Mark I steel containment drywell shell. Specifically, additional guidance is needed for inaccessible areas where the distance between the drywell shell and the surrounding concrete structure is too small for the successful performance of visual inspection. Past operating experience with Mark I steel containments indicates that when water is discovered in the bottom outside areas of the drywell (for example in the sand-pocket area), the most likely cause is the seepage through the space between the drywell shell and the shield concrete.

Numerous requests for additional information (RAIs) on previous and current license renewal applications (LRAs) have been needed to obtain the information needed by the staff to perform its review. The purpose of the proposed LR-ISG-2006-01 is to provide guidance on the information that should be provided in the LRA to reduce the number of RAIs issued to the applicants. Specifically, the staff has determined that applicants for license renewal for a plant with a boiling water reactor Mark I steel containment should provide a plant-specific AMP to address the potential loss of material due to corrosion in the inaccessible areas of the Mark I steel containment drywell shell for the period of extended operation.

The drywell shell is a passive, long-lived structure within the scope of license renewal that is subject to aging degradation. Pursuant to 10 CFR 54.21, the applicant must demonstrate that the effects of

aging will be adequately managed so that the intended function will be maintained consistent with the current licensing basis for the period of extended operation.

Attachment 2--Proposed License Renewal Interim Staff Guidance LR-ISG-2006-01: Plant-Specific Aging Management Program for Inaccessible Areas of Boiling Water Reactor Mark I Steel Containment Drywell Shell

Introduction: Line Item II.B1.1-2 of NUREG-1801, Volume 2, Revision 1, includes a provision for aging management of the Mark I steel containment drywell shells. However, the line item requires additional detail to address the inaccessible areas of the Mark I steel containment drywell shells. Specifically, the line item does not provide guidance when the distance between the steel drywell shell and the surrounding concrete structure is too small for the successful performance of visual examination.

All Mark I containments are free-standing steel construction, except for Brunswick, Units 1 and 2. The Brunswick Mark I containment is a reinforced concrete drywell with a steel liner. A drywell shell is a free-standing steel structure with no concrete backing, whereas the steel liner of a drywell is a leak-tight membrane in direct contact with the concrete containment.

Historical Background: Information Notice (IN) 86-99, "Degradation of Steel Containments," dated December 8, 1986, described an event related to the degradation of the drywell shell at Oyster Creek Nuclear Generating Station. IN 86-99, Supplement 1, dated February 1991, explained that the most likely cause of corrosion of the drywell shell in sand-pocket areas (near the bottom of the drywell) and in the spherical portion of the drywell at higher elevations, was the water in the gap between the drywell and the concrete shield. The source of water was noted as leakage through the seal between the drywell and the refueling cavity. The IN supplement also noted that ultrasonic testing (UT) discovered minor corrosion in the cylindrical portion of the drywell.

Discussion: Generic Letter (GL) 87-05, "Request for Additional Information-Assessment of Licensee Measures to Mitigate And/Or Identify Potential Degradation of Mark I Drywells," requested additional information regarding licensee actions to mitigate and/or identify potential degradation of boiling water reactor Mark I drywells. As a result, most licensees performed UT of their carbon steel drywell shells adjacent to the sand pocket region. In addition, many licensees established leakage monitoring programs for drain lines to identify leakage that may have resulted from refueling or spillage of water into the gap between the drywell and the surrounding concrete.

UT performed as a result of GL 87-05 provided a set of data points to determine the drywell shell thickness that could be compared to the

nominal/minimum fabrication thickness and the minimum thickness required to withstand the postulated loads. These UT measurements taken during the 1987-1988 time frame fall approximately near the mid-point of the current 40-year operating license period for most plants with Mark I steel containments.

The drywell shell is a passive, long-lived structure within the scope of license renewal that is subject to aging degradation. Pursuant to 10 CFR 54.21, the applicant must demonstrate that the effects of aging will be adequately managed so that the intended function will be maintained consistent with the current licensing basis for the period of extended operation.

On the basis of license renewal application reviews and industry operating experience, the NRC staff determined that a plant-specific aging management program (AMP) is needed to address the potential loss of material due to corrosion in the inaccessible areas of the Mark I steel containment drywell shell for the period of extended operation.

Proposed Action: In addressing Line Item II.B1.1-2 of NUREG-1801, Volume 2, Revision 1, applicants for license renewal for plants with a Mark I steel containment need to provide a plant-specific AMP that addresses the potential loss of material due to corrosion in the inaccessible areas of the Mark I steel containment drywell shell for the period of extended operation.

In conducting the aging management review of the drywell shell, the applicant should consider the following:

(1) Develop a corrosion rate that can be reasonably inferred from past UT examinations or establish a corrosion rate using representative samples in similar operating conditions, materials, and environments. If degradation has occurred, provide a technical basis using the developed or established corrosion rate to demonstrate that the drywell shell will have sufficient wall thickness to perform its intended function through the period of extended operation.

(2) Demonstrate that UT measurements performed in response to GL 87-05 did not show degradation inconsistent with the developed or established corrosion rate.

(3) Where degradation has been identified in the accessible areas of the drywell, provide an evaluation that addresses the condition of the inaccessible areas for similar conditions.

(4) To assure that there are no circumstances that would result in degradation of the drywell, demonstrate that moisture levels associated with accelerated corrosion rates do not exist in the exterior portion of the drywell shell, i.e., (1) the sand pocket area drains and/or the refueling seal drains are monitored periodically; (2) the top of the sand pocket area is sealed to exclude water accumulation in the sand pocket area; and/or alarms are used to monitor regions for moisture/

leakage.

(5) If moisture has been detected or suspected in the inaccessible area on the exterior of the drywell shell:

(a) Include in the scope of license renewal any components that are identified as a source of moisture, such as the refueling seal, and perform an aging management review.

(b) Identify surface areas requiring examination by implementing augmented inspections for the period of extended operation in accordance with the American Society of Mechanical Engineers (ASME) Section XI IWE-1240 as identified in Table IWE-2500-1, Examination Category E-C.

(c) Use examination methods that are in accordance with ASME Section XI IWE-2500, which specifies:

(i) Surface areas accessible from both sides shall be visually examined using a VT-1 visual examination method,

(ii) Surface areas accessible from one side only shall be examined for wall thinning using an ultrasonic thickness measurement method,

(iii) When ultrasonic thickness measurements are performed, one-foot square grids shall be used, and

(iv) Ultrasonic measurements shall be used to determine the minimum wall thickness within each grid. The location of the minimum wall thickness shall be marked such that periodic reexamination of that location can be performed.

(d) Demonstrate through use of augmented inspections performed in accordance with ASME Section XI IWE that corrosion is not occurring or that corrosion is progressing so slowly that the age-related degradation will not jeopardize the intended function of the drywell shell through the period of extended operation.

(6) If the intended function of the drywell shell cannot be demonstrated for the period of extended operation (i.e., wall thickness is less than the minimum required thickness), identify actions that will be taken as part of the aging management program to ensure that the integrity of the drywell shell will be maintained through the period of extended operation.

[FR Doc. E6-7000 Filed 5-8-06; 8:45 am]
BILLING CODE 7590-01-P

EXHIBIT C - MONITORING

1. **Summary**
2. **Airborne Monitoring Systems**
3. **Environmental Monitoring**
4. **Meteorological Monitoring**
5. **Monitoring Exhibit Attachment**

Exhibit C-1 Summary

Entergy, and Boston Edison before, has repeatedly said that the amount of radiation released is so small that it is inconceivable that the any cancer or negative health effect would be caused.

This is contradicted by the most recent compilation of research by the National Academies of Science that concluded that there is no safe level of radiation.

An additional fundamental flaw in the applicant's claim is **no one knows how much radiation Pilgrim has actually been released**; and no one will know how much will be released from 2012-2032, during either normal operations or a severe accident.

There are a number of reasons that this is so. The air and environmental monitoring programs can not be relied upon to produce accurate data. Entergy's and Boston Edison's explanations for elevated radiation often are not credible.

To have reasonable assurance that public health and safety will be protected 2012-2032, the following changes in the monitoring program must occur.

1. Environmental monitoring program must be changed as follows:

- control stations placed outside the area of PNPS' influence, outside the Emergency Planning Zone [EPZ] communities;
- number and type of samples expanded;
- split samples provided to an in independent source;
- analysis and reports performed by an independent laboratory, not one owned by the applicant;
- monitoring wells to test for groundwater contamination and migration placed on site, especially along the edge of Cape Cod Bay.

2. Monitoring air emissions modified to include:

- Off-site releases - upgrade equipment by installing combination weather/ radiation detection and measurement devices, fix-mounted to provide real-time measurements, placed in appropriate locations as determined by a site-specific meteorological study;
- on-site monitors upgraded.

3. Multidimensional plume dispersion models, Class B Models; and multiple meteorological towers placed in the seven surrounding towns [Carver, Duxbury, Kingston, Pembroke, Plymouth, Plympton] and on Cape Cod according to site specific meteorological analysis performed, for example, for the Commonwealth by Dr. J.D. Spengler and Dr. Bruce Eagan.

Exhibit C-2 Airborne Monitoring Systems

A. On-site Monitors
B. Sage System
C. Thermo luminescent Dosimeters [TLDs]
D. High School Monitors

A. On-Site Monitors, deficiencies [1]

1. Radiation Monitoring Systems

Radiation detectors are located at exit points from the plant to measure gaseous radioactive effluents. These detectors monitor the gross gamma radiation of gaseous effluents as they pass by. These readings are monitored and recorded in the control room, and when the radiation level approaches release limits, either the effluents can be diverted to another system for further processing, or the power level of the reactor can be reduced in order to reduce the amounts of radioactivity produced. The **radiation detectors are sensitive only to the total amount of radiation impinging on them, they don't differentiate between one isotope and another**, since there are substantial assumptions regarding short half-lives of isotopes entering the systems. One fundamental limitation to measuring gamma radiation levels exiting the plant ventilation systems is that a small perturbation in the total amount of radiation detected, since the decay rate is so much lower compared to short half-life isotopes. **In this way, a leak of long half-life isotope could go undetected by a radiation detector.** The use of chemical and gamma spectrographic analysis is designed to augment the stack radiation monitoring program.

2. Chemical and gamma spectroscopic analysis techniques used to estimate release rates of individual nuclides

Periodic sampling and analysis techniques are employed to determine the relative abundance of various isotopes that are being released. This is very important since the biological action and possible impact is quite different for different isotopes. The way this is carried out is that radioactive effluent is sampled by systems that employ filters and charcoal to draw air through them. After a given period of time, the contents of the filters and charcoal are analyzed by measuring the radioactive decay rate as a function of disintegration energy. Since isotopes decay by emitting radiation of characteristic energies, the amount of a given isotope present in the sample can be estimated by the magnitude of the number of disintegrations at characteristic energies. The uncertainties associated with this method are that in general isotopes emit a spectrum of radiation frequencies, and in a case where there are a large number of unknown isotopes present in the sample, the energy peaks can overlap for different species and **it may not be possible to assay many isotopes with any accuracy.** Another problem that can occur is that the **efficiency of the charcoal absorber is strongly a function of relative humidity**, so in cases of high humidity, the amount of a given isotope present in the charcoal may not at all reflect the concentrations in the sampled effluent. Detectors used to perform these measurements have non-uniform responses to different energy peaks, and calibration of these sensitive instruments should be conducted frequently. Finally, the raw measurements from these instruments are entered into equations to estimate actual release rates, so the associated uncertainties may be quite high.

3. The Direct Torus Vent System (DTVS) was installed because it was recognized that there was something like a 90% probability of that containment failing. In order to protect the Mark I containment from a total rupture it was determined necessary to vent

[1] Ellen B. Cargill, R.T., PhD, Survey of Documents Concerning the Operation of Pilgrim Nuclear Power Station, Preliminary Draft, provided to Petitioners by Author.

any high pressure buildup. The DTVS does not have a filter; therefore unfiltered material will be vented into the neighborhoods. The DTVS provides reason to add additional monitoring to better assess what was released after its use.

B. Existing Off-Site Monitors, Deficiencies - Sage, TLD's, High Schools

Off-site monitors to measure airborne emission of radionuclides from the Pilgrim NPS include: the Sage System consisting of 14 real-time monitors installed on the edge of Pilgrim NPS's property; thermo luminescent docimeters (TLD's) placed in locations 0 to >15 km from Pilgrim NPS; real-time monitors placed in a few schools for the sole purpose of educating students.

1. Sage System [Computerized "Ring" Monitors] – Deficiencies
   - The Sage System does not provide any significant protection to the citizens of Southeastern Massachusetts. The "NRC Draft Report For Comment On Findings On Issues Of Offsite Emergency preparedness For the Pilgrim Nuclear Power Station [NUREG-1438], issued May 1991, expressly noted that MDPH installed this system, "even though fixed offsite monitors are no longer endorsed by the NRC..."[page 2-159].
   - Under the agreement with Boston Edison Company [BECO], the previous licensee, the monitors were installed less than a quarter of a mile from the plant. Yet, the NRC has found that monitors closer than 1000 meters [about 2/3 of a mile] would provably provide inaccurate readings in the event of an accident.
   - The agreement included 22 potential monitoring sites, but only 14 have been installed. Again this is contrary to NRC research on real time monitoring, which concluded that using as few as 14 monitors would grossly underestimate the radiation from narrow emission plumes.
   - The monitors are only in a small quadrant behind the plant. Therefore, there is no effective monitoring in the directions of Scituate, Marshfield, Duxbury, Kingston, or much of Plymouth [including the Gurnet, Saquish neck at the end of Duxbury barrier Beach}. Granted, the plant is on the coast but there is no reason why monitors are not placed on Gurnet, and on strategically placed locations on Duxbury, Kingston, Plymouth shores and interior locations.
   - There are no monitors on Cape Cod. The Cape is across open water -- nothing to break up a plume. The Cape has statistically significant breast and prostate cancers which epidemiology studies to date have not been able to completely explain.
   - The placement of the Sage monitors effectively ignores the results of wind analysis done by the Harvard School of Public health, under the direction of Dr. J.D. Spengler and Dr. G.J. Keeler, May 12, 1988 that described the variability of coastal winds and that the sea breeze effect brought winds inland > 10 miles. Also a true ring of monitors is feasible. At Seabrook NPS, the Citizens Monitoring Network is installing monitors on buoys at sea.
   - The Sage monitors do not measure high and low let alpha and beta radiation.
   - The Sage System also seems subject to the critical deficiencies outlined by Alfred Schmidt in his enclosed comments to EPA, March 31, 1992. For example, he

states "Many of the off-site air sampling systems are ...deficient because they are housed in virtually closed metal shelters which seriously restrict the flow of particle laden air to the collection filters." Schmidt's report is attached at the end of the Monitoring Exhibit.

- The Sage System lacks software to make sense out of the computer data arriving at Massachusetts Department of Public Health [MDPH]. The data has not been systematically graphed, charted or reported to the public.

2. TLD's - Thermo luminescent dosimeters placed in offsite locations ranging from 1 km (.6 miles) to > 15 km (9.3 miles) to measure gamma radiation levels. These devices are passive in as much as they must be in place for a period of time [3 months] and then brought back to the laboratory to determine the amount of radiation the device received at that location for that period of time.

Pilgrim Radiological Monitoring Program Report, 2004
Off-site TLDs – location and number

Zone	Distance	Number
1	0-3 km (0- 1.8 miles)	45
2	3-8 km (1.8 -4.9 miles)	21
3	8-15 km(4.9 – 9.3 miles)	10
4	> 15 km (9.3 miles)	7

Deficiencies TLD's

- TLD's provide only an average figure, and increases of potential significance can be masked by lower than average readings during other parts of the month. Biological impact occurs on a daily basis.
- TLD's can only read to a maximum threshold, that is, like a film badge they can only read so high.
- TLD's do not read high or low let alpha and beta.
- Dr. Hoffman, at Penn State, did an analysis of TLD's and concluded they provided poor sensitivity to Zenon 133. He said it took about 85 hours at maximum concentration before anything showed up and that even then the amount was underestimated by a factor of around 20.

3. High School Monitoring Project - This system consists of radiological and meteorological monitoring systems at each of seven high schools [3 in Plymouth; 1 each in Carver, Kingston, Duxbury and Marshfield]. These on-line monitoring stations are connected by modem to each other and to MDPH.

Deficiencies:

- This program was initiated by the Governor's Council on Radiation Protection solely as a teaching device for the students, not as a monitoring device to protect public

health and safety. They recognized that this important job could not be left to a changing collection of teachers, students or janitors, working part-time and not trained technicians.

- It is overly optimistic to assume that the schools are all coincidentally placed in the most favorable locations in regard to population density and meteorological conditions.
- The High School monitors, like the Sage, have poor sensitivity to low energy gamma and beta. To be protective of public health they should measure gamma, beta and alpha radiation, at both the high and low energy levels. For example Iodine-125 is at the 60 KeV and most iodine's are under 100 KeV.
- Calibration and testing of equipment is not adequately and consistently performed.

Exhibit C -3 Environmental Monitoring

Petitioners reviewed the PILGRIM NUCLEAR POWER STATION Radiological Environmental Monitoring Program Reports (REMP).

The Radiological Environmental Monitoring Program reports can not be relied upon to produce accurate data. The Applicant collects the samples to determine Pilgrim's radiological impact on the general public. The so-called "control stations" are too close to the reactor; in actuality, they are indicator stations. Fewer sample media and numbers now are taken than before; fewer are required. Since July 2002, the Applicant's own laboratory analyzes the samples for radioactivity. Reports for the NRC and public are prepared by the Applicant, Entergy. Finally high deposition of radiation found is dubiously attributed to sources other than Pilgrim NPS.

A. Sampling –obtained by applicant; control stations located too close to Pilgrim

Sampling and Analysis: The **environmental** sampling media collected in the vicinity of PNPS and at distant locations included air particulate filters, charcoal cartridges, seawater, shellfish, Irish moss, American lobster, fishes, sediment, milk, cranberries, vegetation, and animal forage." [2]

The sampling locations are divided into two classes, indicator and control. Indicator locations are those that are expected to show effects from PNPS operations. The REMP states that while the indicator locations are typically within a few kilometers of the plant, the control stations should be located so as to be outside the influence of Pilgrim Station.

However, many so-called control stations are too close to Pilgrim - within sight of the reactor and within the official Emergency Planning Zone Communities, [10 miles or 16 kilometers]. In reality they are indicator stations. If radiation is above expected in a sample collected from a so-called "control station" it is attributed to weapons fallout, not Pilgrim. Also the location of the "control stations" ignores the fact that radioactive particulates released to the air from the stack, will be carried by the wind some distance and deposited some distance from the reactor site –in the control locations.

[2] Ibid

Locations of control stations- Pilgrim NPS:[3]

DESCRIPTION	DISTANCE/LOCATION
SURFACE WATER	
Powder Point Control	13 km NNW (8.07 miles)
IRISH MOSS	
Brant Rock Control	18 km NNW (11.2 miles)
SHELLFISH	
Duxbury Bay Control	13 km NNW (8.07 miles)
Powder Point Control	13 km NNW (8.07 miles)
Green Harbor Control	16 km NNW (9.9 miles)
LOBSTER	
Duxbury Bay Control	11 km NNW (6.8 miles)
FISHES	
Jones River Control	13 km WNW (8.07 miles)
SEDIMENT	
Duxbury Bay Control	14 km NNW (8.7 miles)
Green Harbor Control	18 km NNW (11.2 miles)

Less is sampled now than before

Milk, a key indicator, is not sampled anymore. Prior to 2000, milk samples were obtained from an indicator station, Plymouth County Farm, and from a control station located in Whitman. Plymouth County Farm stopped milking cows and since that time Entergy has claimed that they could not identify any additional milk animals within 5 kilometers [3.1 miles] of Pilgrim. Petitioners contend that milk samples > 5 kilometers could be indicator stations. Additionally there are farms nearby. Plimouth Plantation is about 3 and ½ miles from Pilgrim and has a farm with lactating cows and goats. The oldest operating dairy farm in the Northeast is located in Duxbury.

Other sampling media dropped:

[3] Entergy, Terrestrial and Aquatic Sampling Locations, Pilgrim Nuclear Power Station, Radiological Monitoring Program, Report No. 32, January 1 through December 31, 1999, Figure 2.2-5, page 64

In regard to terrestrial sampling, routine collection and analysis of soil samples was discontinued; instead they claim that if air sampling showed an early indication of any potential deposition of radioactivity, follow-up soil sampling could be performed on an as-needed basis. This assumes that the air monitoring is reliable and accurate; Petitioners contend otherwise.

In the area of marine sampling, the following changes were made.

- A sample of the surface layer of sediment is collected, as opposed to specialized depth-incremental sampling to 30 cm and subdividing cores into 2 cm increments.
- Standard LLD levels of about 150 to 180 pCikg were established for sediment, as opposed to the specialized LLDs of 50 pCi/kg.
- Specialized analysis of sediment for plutonium isotopes was removed.
- Sampling of Irish moss, shellfish, and fish was rescheduled to a semiannual period, as opposed to a specialized quarterly sampling interval.
- Analysis of only the edible portions of shellfish (mussels and clams), as opposed to specialized additional analysis of the shell portions.
- Standard LLD levels of 130 to 260 pCVkg were established for edible portions of shellfish, as opposed to specialized LLDs of 5 pCVkg.

Petitioners contend that what was dropped has resulted in loosing important data required, "to assess the impact of Pilgrim Station on the environment and on the general public." And what was dropped appears to be connected to elevations of radioisotopes in the environment found in previous years. For example:

Plutonium on Duxbury Beach:

Plutonium historically have been found in Duxbury Bay sediment samples[4]; Entergy has attributed the Plutonium to either weapons testing, cross-contamination from their lab's glassware or they simply lost the sample.

It seems far more likely that the plutonium is from PNPS - it is within eye sight -rather than from a Chinese bomb launched thousands of miles away. It would be coincidental if

---

[4] REMP Report, 1998: Sediment Radioactivity Analyses, Plutonium 239/240 was detected in four of the indicator station samples, as well as in the control station samples; REMP Report, 1999: 2.17 Sediment Radioactivity Analyses Pu-239/240 in the samples collected from the control locations; REMP Report, 2000: Plutonium-238 detected in 2 of 4 indicator samples , and both control samples; REMP Report, 2001: Follow-up investigations conducted by the analytical laboratory that performed the 2000 analyses concluded that the results were invalid due to cross-contamination from laboratory glassware. This laboratory also analyzes samples for Department of Energy clean- up projects. Due to the expense of the specialized glassware, it is re-used. Plutonium in indicator samples; REMP Report, 2002: Although records indicate that the samples were collected and delivered to the analytical laboratory in June, analyses were not performed and the samples could not be located... Two of the samples from the control location in Duxbury were to be analyzed for plutonium; REMP, 2003

the beaker used to test the sample at Entergy's own lab just happened to be improperly cleaned and just happened to be contaminated with Plutonium. It seems coincidental that the next years' plutonium sample happened to get lost.

B. Monitoring Wells for groundwater contamination: There are no monitoring wells to test for radioactive contaminated water flowing off-site. The water on-site is not used for drinking; they are not required to have monitoring wells.

However radioactive waste is buried on site and leaks from buried pipes and tanks and from other components can leak into the ground and migrate, as occurred at Braidwood and other sites discussed in the Motion. Absent monitoring wells, there is no reasonable assurance that radioactive material will not, or has not, migrated. From reading Pilgrim's original Environmental Impact Statement it is clear that wells must be placed along the shoreline of Cape Cod Bay;

> Surface topography is such that drainage from the Station is seaward and surface water will not leave the property otherwise. Subsurface water follows the surface topography, resulting in overall movement of water toward the Bay.[5]

Also they should be placed at any other appropriate on-site locations.

C. Analysis of Samples - self analysis: Beginning in July 2002 Pilgrim began to use Entergy's J.A. Fitzpatrick Environmental Laboratory for analysis of environmental samples. Petitioners contend, and are prepared to demonstrate to the ASLB, that results can vary considerably depending on who analyzes the data and reports the findings. A clear conflict of interest is present when the applicant's own company both analyzes the data and reports the results.

D. Attributing elevated readings to other causes: If radioactivity is discovered that could be attributed to Pilgrim, the response is to attribute the contamination to other sources and/or request NRC to change the monitoring requirements.

Example, Plutonium on Duxbury Beach: Plutonium historically have been found in Duxbury Bay sediment samples[6]; Entergy has attributed the Plutonium to either weapons

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[5] Boston Edison Company, Pilgrim Nuclear Power Station Docket No. 50-293, May 1972, United States Atomic Energy Commission Division of Radiological and Environmental Protection, page.11

[6] REMP Report, **1998:** Sediment Radioactivity Analyses, Plutonium 239/240 was detected in four of the indicator station samples, as well as in the control station samples; REMP Report, **1999:** 2.17 Sediment Radioactivity Analyses Pu-239/240 in the samples collected from the control locations; REMP Report, **2000:** Plutonium-238 detected in 2 of 4 indicator samples , and both control samples; REMP Report, **2001:** Follow-up investigations conducted by the analytical laboratory that performed the 2000 analyses concluded that the results were invalid due to cross-contamination from laboratory glassware. This laboratory also analyzes samples for Department of Energy clean- up projects. Due to the expense of the specialized glassware, it is re-used. Plutonium in indicator samples; REMP Report, **2002:** Although records indicate that the samples were collected and delivered to the analytical laboratory in June, analyses were not performed and the samples could not be located... Two of the samples from the control location in Duxbury were to be analyzed for plutonium; REMP, 2003

testing, cross-contamination from their lab's glassware or simply they lost the sample. It seems far more likely that the plutonium is from Pilgrim located within eyesight than from a Chinese test bomb; it would be coincidental if the beaker used to test the sample at Entergy's own lab just happened not be properly cleaned and just happened to be contaminated with Plutonium; it seems coincidental that a sediment sample testing for plutonium on Duxbury Beach in the following year just happened to get lost.

Example, Milk: Milk historically showed elevated levels of contamination. However as mentioned above milk is no longer tested, although lactating animals are available in the area at Plimoth Plantation approximately less than 5 miles away and at a dairy farm in Duxbury, within the Emergency Planning Zone.

Previously milk was tested in farms near Pilgrim and at a control station in Whitman, 22 miles away. The Radiological Environmental Monitoring Program Report (REMP) for 1980 noted that, at the farms around Pilgrim, "the measured average concentration of both Cesium-137 and Sr-90 were respectively 10,000 and 1,000,000 times in excess of the concentrations expected to be present..." and went on to say that this "is unquestionably due to atmosphere testing." The effort to blame the increase on "atmosphere fallout" ignores a critical fact – no similar increase was experienced at the control station in Whitman, How fallout was able to find Pilgrim's farms while simultaneously missing those in Whitman, is beyond comprehension.

The 1982 REMP report stated that the highest mean value occurred at the Kings Residence, located < 5 miles from PNPS, in late June 1982. There were concentrations greater than 1,000,000 times in excess of the concentration expected. The report, written by Tom Sowden [who continues to work in this area at PNPS] stated,

> It is not uncommon to find marked increase of Cs-137 associated with the cow's pregnancy, and this was most likely the cause. [7]

However the large animal expert at Tufts Veterinarian School was of a different opinion. He stated that,

> Cows normally do not lactate during pregnancy. And, an animal can not produce Cs-137 on their own. It (Cs-137) must be introduced into the cows system from an environmental source. The cow would have to ingest it in some way."

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[7] REMP 1982, p. 3-69.

Exhibit C -4 Meteorological Monitoring

Recommendation:
Multidimensional plume dispersion models, Class B Models; and multiple meteorological towers placed in the seven surrounding towns impacted by the sea breeze effect that were identified by Dr. J.D. Spengler[8] [Carver, Duxbury, Kingston, Pembroke, Plymouth, Plympton] and towers located appropriately on Cape Cod in consideration of the site specific meteorological analysis of Cape Cod performed for the Commonwealth by Dr. Bruce Eagan.

Rationale:
Realistic modeling assumptions and meteorological data are the key to forecasting and implementing appropriate and effective emergency response plans and assessing damage afterwards.

Pilgrim Currently Uses Class A Models and Onsite Meteorological Tower

Currently, Pilgrim uses Class A plume transport models and relies on weather information from their onsite meteorological tower. Neither provides accurate data.

The Class A plume models used incorrectly assumes a steady-state, straight-line plume transport; although actual wind and weather conditions are variable and complex affected by sea and lake breezes, terrain, location/clustering of buildings, and variable precipitation.

Pilgrim should use complex Class B models now and from 2012-2032 if the license is extended.

The on-site Met Tower only tells us what the wind direction is on site but not what happens to the plume as it travels offsite. Therefore Pilgrim should use data from multiple weather stations now and from 2012-2032, if the license is extended.

NRC and EPA Guidance Support Multidimensional Modeling and Multiple Weather Stations

Federal Guidance dating back to the 1970's support the need for Class B models and multiple meteorological towers properly placed throughout this area...

1) Since the 1970s, the NRC has historically documented all of these advanced modeling technique concepts and potential need for multiple meteorological towers especially in coastal site regions. [9]

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[8] Dr. J.D. Spengler and Dr. G.J. Keeler, Feasibility of Exposure Assessment for The Pilgrim Nuclear Power Plant, May 12, 1988

[9] Excerpts from NRC Regulatory Guide 1.23 (Safety Guide 23) Onsite Meteorological Programs, 1972 "The number of locations on a site at which meteorological measurements are necessary will

2) In January 1983 NRC Guidance suggested that changes in on-site meteorological monitoring systems would be warranted if they have not provided a reliable indication of monitoring conditions that are representative within the 10-mile plume exposure EPZ.[10]

3) EPA's latest Guideline on Air Quality Models (Federal Register November 9, 2005) state in Section 7.2.8 *Inhomogeneous Local Winds* that,

> In many parts of the United States, the ground is neither flat nor is the ground cover (or land use) uniform. These geographical variations can generate local winds and circulations, and modify the prevailing ambient winds and circulations. Geographic effects are most apparent when the ambient winds are light or calm. In general these geographically induced wind circulation effects are named after the source location of the winds, e.g., lake and sea breezes, and mountain and valley winds. In very rugged hilly or mountainous terrain, along coastlines, or near large land use variations, the characterization of the winds is a balance of various forces, *such that the assumptions of steady-state straight-line transport both in time and space are inappropriate (italics added).*

EPA goes on to say that

> In the special cases described, refined variable trajectory air quality models can be applied on a case-by-case basis for air quality estimates for such complex non-steady-state meteorological conditions.

This EPA Guideline also references an EPA 2000 report, Meteorological Monitoring Guidance for Regulatory Model Applications, EPA-454/R-99-005, February 2000. Section 3.4 of this guidance for Coastal Locations, discusses the need for multiple inland meteorological monitoring sites, with the monitored parameters dictated by the data input needs of particular air quality models.

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depend largely on the complexity of the terrain in the vicinity of the site. For example, the study of a hill-valley complex, or a site near a large body of water would require a larger number of measuring points to determine airflow patterns and spatial variations of atmospheric stability." ....Section 7. "Special Considerations" states that "at some sites, due to complex flow patterns in non-uniform terrain, additional wind and temperature instrumentation and more comprehensive programs may be necessary. Also, measurements of precipitation and/or solar radiation may be desirable at some locations. Occasionally the unique diffusion characteristics of a particular site may warrant use of special meteorological instrumentation and/or studies. Proposed studies of this nature should be described in the application for a construction permit."

[10] NUREG-0737, Supplement 1 "Clarification of TMI Action Plan Requirements," January 1983 Regulatory Guide 1.97- Application to Emergency Response Facilities; 6.1 Requirements, b. Control Room, ".....Provide reliable indication of the meteorological variables (wind direction, wind speed, and atmospheric stability) specified in Regulatory Guide 1.97 (Rev. 2) for site meteorology. No changes in existing meteorological monitoring systems are necessary if they have historically provided reliable indication of these variables that are representative of meteorological conditions in the vicinity (up to about 10 miles) of the plant site. Information on meteorological conditions for the region in which the site is located shall be available via communication with the National Weather Service. These requirements supersede the clarification of NUREG-0737, Item III.A.2.2."

EPA concludes that a report prepared for NRC provides a detailed discussion of considerations for conducting meteorological measurement programs at coastal sites.[11]
Site Specific Meteorological Studies around Pilgrim NPS Commissioned by the Commonwealth of Massachusetts Support Multidimensional Analysis

Site Specific studies specifically stated that Pilgrim's on-site meteorological monitoring systems do not provide reliable indication of monitoring conditions that are representative within the 10-mile plume exposure EPZ. A summary of (2) studies is below – the full reports are attached.

Dr. J.D. Spengler and Dr. G.J. Keeler, Feasibility of Exposure Assessment for The Pilgrim Nuclear Power Plant, May 12, 1988

Summary

1. The sea breeze phenomena are observed at the Pilgrim site.

A sea breeze is a localized wind that blows from the sea to the land. It is caused by the temperature difference when the sea surface is colder than the adjacent land. Therefore, it usually occurs on relatively calm, sunny, spring and summer days. Depending on topography, intensity of solar heating and pressure gradients, a sea breeze front can penetrate inland from 1(.5 miles) to 15 km (9 miles). It can occur throughout the year but it occurs most frequently during the spring and summer months. On average Pilgrim experiences about 45 sea breeze days during these two seasons.

Typically onshore component commences about 10:00 AM and can persist to about 4 PM. The wind direction changes during the day veering from the north around through the southeast quadrant by late afternoon. The intensity of the sea breeze can be measured by the wind speed and distance of inland penetration. The intensity of the sea breeze circulation depends upon solar radiation (which is influenced by cloud cover), sea water temperature, and strength of the gradient wind flow. The intensity and effective inland penetration of the sea breeze front in the near environment of the Pilgrim site are not well characterized.

2. Coast line orientation and topography strongly influence wind patterns (the frequency, direction, and strength of onshore winds).Predominantly in the summer and spring, a sea breeze onshore component is observed along the Massachusetts coast. The dominant sea breeze components are east and east- southeast for Boston-Logan, easterly for Plymouth, northeast and east-northeast f or the Canal site, and east and east-southeast for the Pilgrim

[11] Raynor, G.S.P. Michael, and S. SethuRaman, 1979, Recommendations for Meteorological Measurement Programs and Atmospheric Diffusion Prediction Methods for Use at Coastal Nuclear Reactor Sites. NUREG/CR-0936. U.S. Nuclear Regulatory Commission, Washington, DC.

plant. This finding suggests that the wind speed and direction at one coastal site would not be used as a surrogate for other coastal sites.

3. The meteorological sites available provide limited ability to fully characterize or model the sea breeze circulation in the vicinity of the Pilgrim I Nuclear Power Plant.

Physical modeling of coastal sea breeze circulation patterns is limited by both the number of meteorological sites in the vicinity of the Pilgrim Plant and the number of parameters monitored.

William T. Land, Meteorological Analysis of Radiation Releases For the Coastal Areas of the State of Massachusetts for June 3rd to June 20th 1982

A listing of probable causes resulting in radiation concentration within the microclimate would include (in order of importance):

1. ONSHORE WINDS: Winds from the east and north moving radiation back toward the land away from the coast.

2. WIDESPREAD RAINFALL; Rain which could keep radiation in the lower stratosphere and washout radiation into the ecosystems, food chair and water supplies.

3. COOL DESCENDING AIR; Air which would prohibit radiation from lifting into high altitude winds which would in turn carry the contaminants at the 18,000 foot level safely out to sea.

4. AIR POLLUTION: Pollution which would give added nuclei for radiation to adhere to thereby increasing its ability to stay at lower stratospheric levels.

5. FOG: Fog which would give additional hydroscopic nuclei for both pollution and radiation to coalesce upon.

6. AIR STAGNATION: Stagnation with little or no wind, haze and temperature inversions which in turn have the ability to trap radiation close to the surface.

Conclusion

In light of NRC and EPA's Guidance about the use of refined variable trajectory modeling techniques to provide for more realistic, accurate modeling predictions and site specific meteorological studies demonstrating the complexity of weather here, it is obvious that Pilgrim should update to Class B models and multiple weather stations.

Because Pilgrim has not used appropriate weather monitoring and plume modeling; we do not know, nor does the applicant know, precisely where radiation has or will be deposited.

A straight –line Gaussian model is not applicable here nor can the applicant rely on weather data input from onsite. By relying on the steady-state, straight –line Gaussian model to construct a "key hole" planners are likely to make the wrong call - send citizens into a plume; tell folks to stay put when should evacuate; or tell them to evacuate when should shelter. Class B models must be required if a license extension is granted for 2012-2032. Computerized combination weather-radiation monitors are readily available and also must be required.

Exhibit C-5 Monitoring Exhibit Attachment

05/18/92 14:02 ☎ [illegible] Flaws. Safe Systems

SCHMIDT INSTRUMENT CO.

ENGINEERED AIR SAMPLING INSTRUMENTS

P.O. BOX 111 SAN CARLOS, CALIFORNIA, 94070 (415) 591-8247
(415) 342-2813

March 31, 1992

Mr. William K. Reilly, Administrator,
U.S. Environmental Protection Agency,
401 M Street, S.W.,
Washington, D.C. 20460

Re: Rulemaking Pursuant to the Rescission of Subpart I of 40CFR61 Relating to Commercial Nuclear Power Reactors Licensed by the Nuclear Regulatory Commission

Dear Mr. Reilly,

The purpose of this letter is to provide you with information about some serious deficiencies in the U.S. Nuclear Regulatory Commission's program for limiting emissions from commercial nuclear power reactors, and to ask that there be continued oversight of this program by the U.S. Environmental Protection Agency until these deficiencies are corrected.

My qualifications for writing on this subject include the fact that I am a registered professional engineer; have been working on nuclear air monitoring problems for over 30 years; have written a comprehensive paper on effective stack monitoring that was published in the Proceedings of the 1988 DOE/NRC Nuclear Air Cleaning Conference(1); have lectured on this subject; and currently am a member of the Working Group to update ANSI Standard N13.1 "Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities".

The deficiencies that I am referring to are not in the NRC's regulations but in its lack of performance requirements and testing requirements to make certain that its regulations are being met. Thus there are no NRC performance requirements or testing requirements for either the stack emission monitoring systems or the offsite air monitoring instruments at commercial nuclear power plants.

The importance of the stack monitoring systems can be judged from the fact that they are relied on to detect any radioactive emissions which get past the nuclear air cleaning equipment, and to alert the plant operators in time to take corrective action. If they do not work properly there can be a sizeable amount of radioactive discharge, leading to expensive cleanup problems, liability lawsuits, and increased public distrust of the U.S. nuclear power program.

An example of such a monitoring system failure occurred at the Muehleberg Nuclear Power Station in Switzerland in 1986(2) when the stack monitoring system, which was similar to those at many U.S. nuclear power plants, failed to detect a sizeable emission of radioactive particles which had gotten past the plant's air cleaning system. Investigation afterwards showed that radioactive particles had entered the isokinetic stack sampling probes and then deposited in the sample transport tubing, so that none reached the sampling filter and radiation detector.

A similar failure occurred at the DOE's Waste Isolation Pilot Plant in New Mexico in about 1987 when a multiple nozzle isokinetic sampling probe, similar

to those at many U.S. nuclear power plants, plugged with salt dust after only one day's service and had to be replaced with a new style probe that was designed to have very low particle deposition losses(3).

Why there have not been more stack monitoring system failures at U.S. nuclear power plants can be explained by the fact that normally the sampling probes operate in extremely clean air. It is only when the high efficiency filters and charcoal beds fail, and monitoring is important, that the deficiencies show up.

The emission measurement deficiencies at nuclear power plants that concern me most are as follows:

1. There are no performance requirements for the stack monitoring systems in terms of emission measurement accuracy and the largest particles that must be detected.
2. There are no testing or certification requirements for the stack monitoring systems.
3. There are no professional or educational requirements for the people who design and install these stack monitoring systems, in spite of the technical difficulties in making them work properly, and their importance to public health and safety.
4. Many nuclear stack monitoring probes are not in compliance with EPA Method 1 (40 CFR 60, Appendix A) which specifies the minimum permissible distances from flow disturbances.
5. Calculations based on the DEPO 1.03 computer program(4) show that the small diameter transport lines and long tubing runs, which are typical of many nuclear stack monitoring systems, will selectively remove most of the larger airborne particles that are sampled and prevent them from being measured.
6. Many of the off-site air sampling instruments for nuclear power stations are equally deficient because they are housed in closed metal shelters which seriously restrict the flow of particle laden air to the collection filters.
7. Most significantly, there appears to be no recognition by anyone at the NRC that these deficiencies exist, and there appears to be no plan to do anything about them.

In view of the situation that I have described in this letter, and its importance to public health and safety, I hope that everyone concerned will understand the need for oversight of the NRC's emission measurement program by the U.S. EPA until these deficiencies are corrected.

Very truly yours,

SCHMIDT INSTRUMENT CO.

Alfred C. Schmidt

Alfred C. Schmidt, MS, PE
Consultant

(For the list of references please turn to the next page.)

EXHIBIT D

ECONOMIC IMPACT TOURISM

Exhibit D – Economic Impact Tourism

The Economic Impact of Travel on Massachusetts Counties, 2003A Study Prepared for the Massachusetts Office of Travel and Tourism by the Research Department of the Travel Industry Association of America, Washington, D.C., January 2005

INTRODUCTION

This report presents preliminary 2003 and revised 2002 estimates of the impact of U.S. resident traveler and international traveler spending in Massachusetts, as well as the employment, payroll income and tax revenue directly generated by the spending. These estimates are produced through use of the County/City Travel Economic Impact Model, a computerized economic model producing estimates of travel spending at the county level, and its impact on employment, wage and salary (payroll) income, and state and local tax revenues.

The County/City Travel Economic Impact Model is an extension of TIA's Travel Economic Impact Model (TEIM) initially developed in 1975 for the U.S. Department of the Interior to indicate the economic value of travel and tourism to states and counties. The original TEIM has been revised substantially based upon more accurate and targeted input data available from governments and the private sector.

The TEIM is based upon national travel surveys conducted by TIA and expenditure data developed by the Bureau of the Census, TIA, various federal agencies and national travel organizations each year. A description of the TEIM and the County impact model is provided in Appendix A. The following estimates of travel's economic impact in Massachusetts are based upon the most recent version of the TEIM and data available from the U.S. Census Bureau and other sources.

U.S. residents traveling in Massachusetts includes both state residents and out-of-state visitors traveling away from home overnight in paid accommodations, or on day trips to places 50 miles or more away from home during 2003. Travel commuting to and from work; travel by those operating an airplane, bus, truck, train or other form of common carrier transportation; military travel on active duty; and travel by students away at school, are all excluded from the model. In addition, the payroll and employment estimates represent impact generated in the private sector and exclude public-supported payroll and employment.

Starting in 2003, TIA's TravelScope® has been modified to capture more information from traveling households. This resulted in an overall increase in travel volume and adjustment of the travel economic impact estimates. Based on this change, travel economic impact estimates for 1999-2002 have been revised as well as 2003.

Since additional data relating to travel and its economic impact in 2003 will become available subsequent to this study, TIA reserves the right to revise these estimates in the future.

TRAVEL IMPACT ON MASSACHUSETTS - 2003

Travel Expenditures

- Domestic and international travelers in Massachusetts directly spent nearly $11.2 billion on transportation, lodging, food, entertainment and recreation and incidentals during 2003. This represents a drop of 0.5 percent from 2002, due to the continued decline in international travelers' spending in the state.

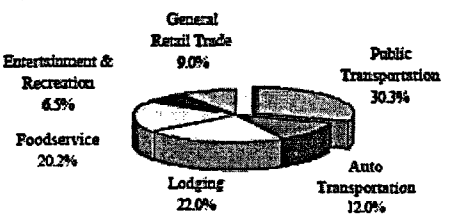
- Domestic and international travelers spent nearly $3.4 billion on public transportation, down slightly, 0.2 percent, from 2002. This is mainly due to the decrease in international traveler spending in Massachusetts.

- Domestic travel spending on lodging declined by 1.6 percent, while international travel spending on lodging dropped by 15.8 percent. In total, travel spending on lodging fell 4.3 percent in 2003.

- Spending on foodservice by domestic travelers reached more than $2.0 billion, 3.4 percent increase from 2002. International travelers spent $233 million on this category, down 14.1 percent.

- Mainly due to higher gasoline prices, domestic travel spending on auto transportation increased by 4.7 percent in 2003.

Travel Spending in Massachusetts in 2003 by Industry Sector



1. Foodservice sector includes restaurants, grocery stores and other eating and drinking establishments.
2. Lodging sector consists of hotels and motels, campgrounds, and ownership or rental of vacation or second homes.
3. Public transportation sector comprises air, intercity bus, rail, boat or ship, and taxicab or limousine service.
4. Auto transportation sector includes privately-owned vehicles that are used for trips (e.g., automobiles, trucks, campers or other recreational vehicles), gasoline stations, and automotive rental.
5. General retail trade sector includes gifts, clothes, souvenirs, and other incidental retail purchases.
6. Entertainment and recreation sector includes such items as golf, skiing and gaming.

Table 6: Travel Expenditures in Massachusetts by Industry Sector, 2002-2003

2003 Expenditures	Domestic ($ Millions)	International ($ Millions)	Total ($ Millions)	% of Total
Public Transportation	$3,224.1	$171.5	$3,395.6	30.3%
Auto Transportation	1,325.8	16.1	1,341.8	12.0%
Lodging	2,051.7	415.0	2,466.6	22.0%
Foodservice	2,024.5	233.1	2,257.6	20.2%
Entertainment & Recreation	618.7	111.1	729.8	6.5%
General Retail Trade	707.6	299.9	1,007.4	9.0%
Total *	$9,952.3	$1,246.6	$11,198.9	100.0%
2002 Expenditures				
Public Transportation	$3,207.0	$194.4	$3,401.4	30.2%
Auto Transportation	1,265.9	17.9	1,283.8	11.4%
Lodging	2,084.3	492.9	2,577.2	22.9%
Foodservice	1,958.5	271.5	2,230.0	19.8%
Entertainment & Recreation	611.9	124.6	736.5	6.5%
General Retail Trade	689.8	339.1	1,028.9	9.1%
Total *	$9,817.4	$1,440.4	$11,257.8	100.0%
Percentage change 2003 over 2002	Domestic (%)	International (%)	Total (%)	
Public Transportation	0.5%	-11.8%	-0.2%	
Auto Transportation	4.7%	-10.2%	4.5%	
Lodging	-1.6%	-15.8%	-4.3%	
Foodservice	3.4%	-14.1%	1.2%	
Entertainment & Recreation	1.1%	-10.8%	-0.9%	
General Retail Trade	2.6%	-11.6%	-2.1%	
Total *	1.4%	-13.5%	-0.5%	

Sources: TIA, OTTI/ITA

** Total domestic expenditures and percent change from previous year may not match those in county tables due to rounding.*

EXHIBIT E

DRY CASK STORAGE

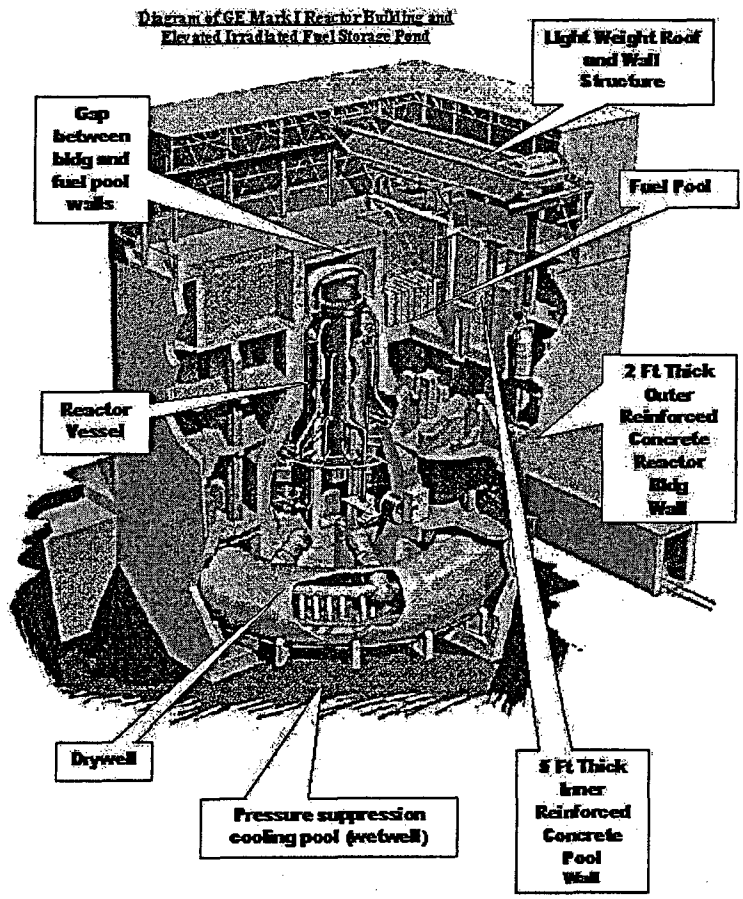
1. **Diagram of GE Mark I Reactor Building and Elevated Irradiated Fuel Storage Pool**

2. **Some Potential Modes of Attack on Civilian Nuclear Facilities**

3. **Cooling Processes in a Partially or Fully Drained Spent-Fuel Pool**

4. **A Proposed Design Approach for Hardened, Dispersed, Dry Storage**

Diagram of GE Mark I Reactor Building and Elevated Irradiated Fuel Storage Pool



Some Potential Modes of Attack on Civilian Nuclear Facilities[12]

MODE OF ATTACK	CHARACTERISTICS	PRESENT DEFENSE
Commando-style by land	• Could involve heavy weapons/sophisticated tactics • Attack requiring substantial planning and resources	Alarms, fences, lightly-armed guards, with offsite backup
Commando-style by water	· Could involve heavy weapons/sophisticated tactics · Could target intake canal · Attack may be planned to coordinate with a land attack	500 yard no entry zone – marked by buoys – simply, "no trespassing" signs Periodic Coast Guard surveillance by boat or plane
Land-vehicle bomb	• Readily obtainable • Highly destructive if detonated at target	Vehicle barriers at entry points to Protected Area
Anti-tank missile	• Readily obtainable • Highly destructive at point of impact	None if missile is launched from offsite
Commercial aircraft	• More difficult to obtain than pre-9/11 • Can destroy larger, softer targets	None

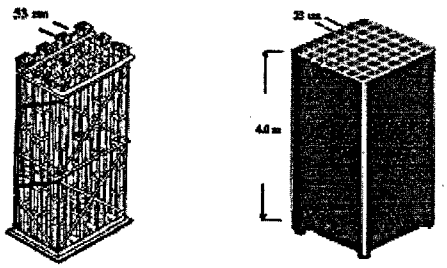
[12] Gordon Thompson, *Robust Storage of Spent Nuclear Fuel: A Neglected Issue of Homeland Security*, p. E-S 5, December 2002. NOTE: Pilgrim Watch added 2nd row to table, ATTACK BY WATER.

E-3

Cooling Processes in a Partially or Fully Drained Spent-Fuel Pool

"Dense packing"[13]

The original design density of spent fuel in the pools had the fuel assemblies spaced out in a loose square array. The standard spacing for new dense-pack racks today is 23 cm - barely above the 21.4 cm spacing in reactor cores. This "dense-packed" fuel is kept sub-critical by enclosing each fuel assembly in a metal box whose walls contain neutron-absorbing boron.



These boron-containing partitions would block the horizontal circulation of cooling air if the pool water were lost, greatly reducing the benefits of mixing recently-discharged with older, cooler fuel. During a partial uncovering of the fuel, the openings at the bottoms of the spent-fuel racks would be covered in water, completely blocking air from circulating up through the fuel assemblies. The portions above the water would be cooled primarily by steam produced by the decay heat in the below-surface portions of the fuel rods in the assemblies and by blackbody radiation.

In the absence of any cooling, a freshly-discharged core generating decay heat at a rate of 100 kWt/tU would heat up adiabatically within an hour to about 600°C, where the zircaloy cladding would be expected to rupture under the internal pressure from helium and fission product gases, and then to about 900°C where the cladding would begin to burn in air. It will be seen that the cooling mechanisms in a drained dense-packed spent-fuel pool would be so feeble that they would only slightly reduce the heatup rate of such hot fuel.

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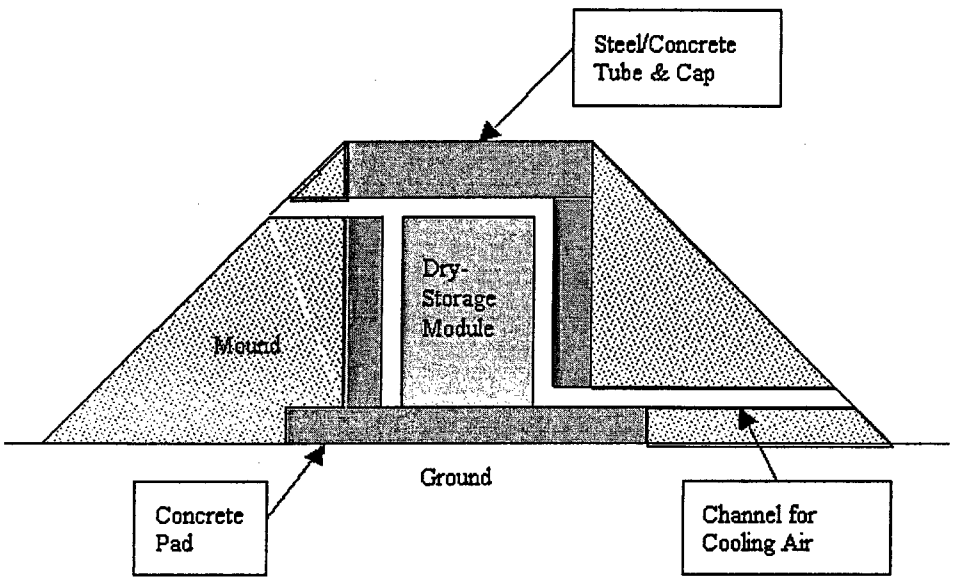
[13] Robert Alvarez, Jan Beyea, Klaus Janberg, Jungmin Kang, Ed Lyman, Allison MacFarlane, Gordon Thompson, Reducing the Hazards from Stored Spent Power-Reactor Fuel in the United States, Science & Global Security, Vol. 11, No.1, (2003) page 16-17.

A Proposed Design Approach for Hardened, Dispersed, Dry Storage[14]

An ISFI design approach that offers a prospect of meeting (desired) DBT involves an array of vertical-axis dry storage modules at a center-to-center spacing of perhaps 25-meters. Each module would be on a concrete pad slightly above ground level, and would be surrounded by a concentric tube surmounted by a cap, both being made of steel and concrete. This tube would be backed up by a conical mound made of earth, gravel and rocks. Further structural support would be provided by triangular panels within the mound, buttressing the tube. The various structural components would be tied together with steel rods. Air channels would be provided, to allow cooling of the dry-storage module. These channels would be inclined, to prevent pooling of jet fuel, and would be configured to preclude line-of-sight access to the dry-storage module. Figure 2...provides a schematic view of the proposed design.



[14] Gordon Thompson, Robust Storage of Spent Nuclear Fuel: A neglected Issue of Homeland Security, A report commissioned by Citizens Awareness Network, January 2003, page 64-65.

Disperse casks so that they are a more difficult target. Pilgrim sits on 1600 acres.

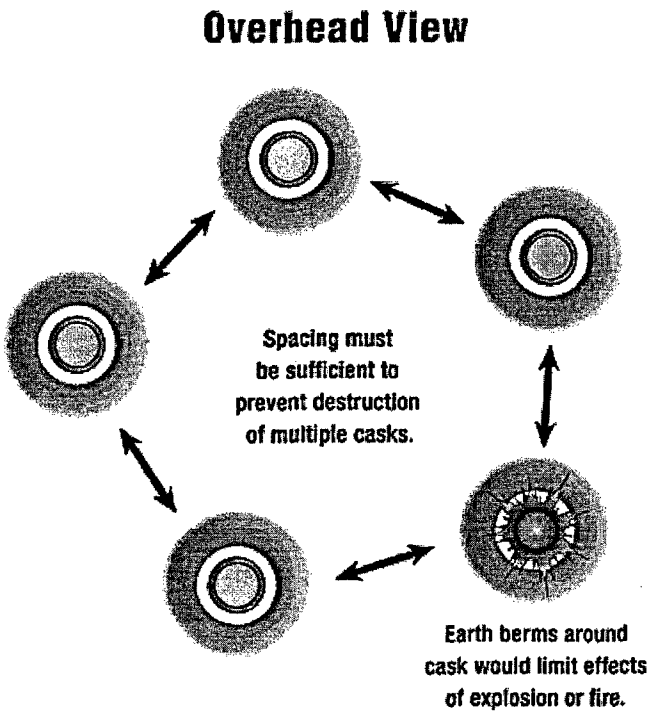


EXHIBIT F

HEALTH

1. Metropolitan Area Planning Council, Baseline: Population and Employment Projections 2010-2032, January 2006,

2. Martha S. Morris, Robert S. Knorr, Adult Leukemia and Proximity-Based Surrogates for Exposure to Pilgrim Plant's Nuclear Emissions, Archives of Environmental Health, July/August 1996 [Vol. 51(No.4)]

3. Richard W. Clapp, Statement before the Southeastern Massachusetts Health Study Review Committee, June 26, 1992 [provided by author]

4. Richard W. Clapp, Sidney Cobb, C K Chan, Bailus Walker, Leukemia near nuclear power plant in Massachusetts, Letter to Lancet, in Valerie Beral, Eve Roman, Martin Bobrow, Childhood Cancer and nuclear Installations, papers, abstracts, editorials, reports published since 1984, BMJ Publishing group, Tavisrock Square, London WC1H 9JR, 1993

Baseline: Population and Employment Projections 2010-2030

For use in the 2006 Regional Transportation Plan and MetroFuture

January 2006

Metropolitan Area Planning Council

Baseline: Population and Employment Projections 2010-2030

For use in the 2006 Regional Transportation Plan and MetroFuture

Metropolitan Area Planning Council

Holly St. Clair, Manager of Metro Data Center
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Mark Fahey, Data Development Group

January 2006

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The Metropolitan Area Planning Council (MAPC) has completed population and employment projections for 164 communities in the Boston area. These projections are used in a wide variety of ways, ranging from estimating likely traffic and water impacts over time, to helping communities determine where and how to grow.

As part of the MetroFuture initiative, MAPC is using the projections of its 101 communities to develop a picture of likely growth patterns in the region, if historical trends are extended. This data will be used to develop alternative strategies for the region's growth and development through the year 2030.[15] PT The projections will also inform the FY2006 update of the Boston Region Metropolitan Planning Organization's 25 year Transportation Plan, where future transportation improvements are identified.

The Boston area regional transportation plan requires projections of population and employment totals to the year 2030. The regional transportation model includes 164 communities in Eastern Massachusetts. Within each community, these projections need to be further broken down into Traffic Analysis Zones (TAZs), which are based on US Census block or block group geography.

We have used standard methodologies to make these projections. For this base scenario of the region's likely future, we have assumed that the future will be mostly like the recent past. Population growth is based on the state birth and death rates, by age-sex-race cohorts for the region, and on a community's overall recent growth trends. Net population migration for the region is also based on the trend of 1990s. The employment trends are based on national growth projections by industry sector and on what proportion of this national growth might be captured by Eastern Massachusetts, as well as each community's share of our recent growth.TP[16]PT

The projections have been improved through a public review period where the 101 municipalities, 6 adjoining RPAs and 2 collaborating agencies, Central Transportation Staff (CTPS) and the Executive Office of Transportation (EOT) were invited to comment.

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[15] MetroFuture is MAPC's large-scale participatory initiative to develop a *vision* for the Metro Boston region's future and a *strategy* to get there. This initiative will use scenario modeling to look at different possible futures. Each scenario will be based on different assumptions about how and where we might grow, allowing us to look carefully at the consequences of that growth. (www.metrofuture.org)

TP[16]PT A note on the previous MAPC projections: MAPC produced population and employment projections in 2003 that may have produced different numbers for communities. In an attempt to better capture the trends documented in the community comments and influenced by MetroFuture's need for a method that could be adapted to allow the employment and population projections to interact, a different method was adapted.

These projections have also been allocated to Traffic Analysis Zones (TAZs) within each community. Traffic Analysis Zones provide the regional transportation model with a finer level of detail for analyzing trips around the region and links land use patterns to growth projections for MetroFuture's "base case" for the region. The allocation among TAZs in each community begins with the 2000 Census results for population along with year 2000 employment patterns developed by CTPS. Allocations of growth to each TAZ are based on historic land use trends and existing zoning within each community.

Further details on these projection methodologies are presented in this document.

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BASELINE PROJECTION METHODS

A geographic two-stage approach is taken for these projections. Regional totals are developed first and then these totals are allocated to the municipal level. Under this approach, our region as a whole is viewed as an independent socioeconomic area which responds to long-term national socioeconomic changes. Regional population projections are based on the demographic characteristics of each age-sex-race specific cohort of the region. Regional employment projections are based on both national economic structural change and region-specific characteristics. These regional projections are then allocated into each municipality reflecting the trend of each municipality's growth characteristics in the region

Population

Data

The following statistical information was used for the population projections: 1) state, regional, and community population by age, sex, and race groups, from 1985 and 2000 from the U.S. Bureau of the Census as modified by Massachusetts Department of Public Health with bridged race categories; 2) state-level annual births and deaths from 1989 to 2001 from the Massachusetts Department of Public Health to calculate natural increase; 3) state-level birth rates for age, race and the sex of the child from the Massachusetts Department of Public Health to project births; 4) state-level age-sex-race-specific death rates for Massachusetts in the form of a life table from the U.S. Bureau of the Census. Due to lack of migration data by cohort, the net migration rate is indirectly estimated by comparing the projected natural change from 1990 to 2000 and the actual population of 2000. This net migration method is discussed below.

Natural Change: Birth and Death Rate

The population is broken down into (1) 18 age cohorts from 0-4 to 85 and over, (2) by sex and (3) four race categories: Hispanic, non-Hispanic white, non-Hispanic black and other. Natural change for each cohort is calculated by taking the population by age-sex-race group at a starting point, multiplying the age-sex-race groups by age group-specific survival rates, and adding in surviving newly born children.

Birth rates by age and race of mother and sex of child are calculated by taking the number of births by age and race of mother and sex of child for years from 1999, 2000, 2001.T[17]PT Births are averaged over three years and then divided by the number of women in the mothers' age-race group. The one-year birth rate created by this calculation is multiplied by five to create five-year birth rates. Births in the new 0-4 age cohorts were calculated by the specific birth rates by age-race of mother and sex of child and then multiplying those rates by the corresponding estimated female age-race group populations.

Each cohort (including the newborn 0-4 group) was then multiplied by the age-sex-race specific survival rate calculated for Massachusetts. The result of this calculation will give an estimate of how many individuals from each age group will have survived.

Net Migration

Historical net migration is calculated by subtracting the expected population in an end point period from the actual population reported by the US Census. The expected population is calculated by using only the natural increase method discussed above. For these projections, natural increase was calculated for the 164-community region from 1990 to 2000.TP[18]PT The result of this calculation would be considered the expected population in 2000. The expected population is subtracted from the actual population reported by the US Census in 2000 to determine the difference between the two figures. The difference or net migration represents the population that either moved in (net positive migration) or out (net negative migration) of the community over the past 10 years.

Using the above absolute migration calculations for each cohort, the migration rate of each age-sex-race cohort is calculated by dividing the net number of people that migrated in each cohort by the average number of individuals that existed in that cohort in 1990 and 2000.TP[19]PT

Regional Population Projection

Population projections for the region (164 communities) as a whole were created through use of the Cohort-Migration-Survival method by age, sex and race group as discussed earlier. This establishes consistency between past decade-by-decade population and age group fluctuations, and ties levels of expected natural increase to estimated net migration as a remainder. These relationships are then projected (continued) into the future. A diagram depicting the population projection method is included on page 4.

For example, year 2010 for the 164-community region was calculated by using the US Census 2000 population as a starting point. Natural increase from 2000 to 2010 was calculated for the region using state-level age-sex-race specific birth and survival rates.

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[17] Method adopted from Andrew Isserman's "The Right People, the Right Rates" (Journal of the American Planning Association, Vol. 59, No. 1, Winter 1993)

TP[18]PT Census information necessary to calculate net migration by consistent race categories is not available before 1990.

TP[19]PT We constrained all age-sex-race specific 5-year migration rate to a ceiling/floor of 10%. This constraint prevents cohorts from having unusually high or low migration rates, and was imposed on 38 of the 144 age-sex-race cohorts.

The net migration result, which is derived by multiplying the migration rate by the number of people in each age group that survived from the starting period, is then added or subtracted to the surviving population in each age group.

For a numerical example, if 100 people existed in an age-sex-race group in the starting period of 2000 and 90 survived to the period of 2010, and there was a migration rate of +10% or 9 people, then the 2010 ending population would be 99. This natural increase and net migration method was repeated every ten years until 2030.

The regional projection for each decade is then allocated into each community.

Municipal Level Population Projections

Each community has a historical proportion of the region's population. The trend in each municipality's share of the population was calculated from 1970 to 2000 by decade. From these municipal share trends, we then statistically estimate a logarithmic curve that best fits the historical trend for the share of each municipality. This estimated curve is then used to project each municipality's share in the future.

The municipal level projections are a hybrid approach based on (1) age-sex-race cohort specific share of the region and (2) municipal total population share of the region. The former approach helps us to understand the change of cohort composition of each municipality and the latter approach helps us to estimate the overall population trend of each municipality.

First, we applied the same population projection method, which is used for the regional projection, onto each municipality to see the solely demographic-change based projection. Then, we adjusted the first step projection outcome with the total population trend estimated from the second approach.

As a consequence, we generated each municipality's population projection by age cohort based on each community's trend in the share of the projected regional cohort.

EXHIBIT F-2

Health

Martha S. Morris, Robert S. Knorr, Adult Leukemia and Proximity-Based Surrogates for Exposure to Pilgrim Plant's Nuclear Emissions, Archives of Environmental Health, July/August 1996 [Vol. 51(No.4)]

Adult Leukemia and Proximity-Based Surrogates for Exposure to Pilgrim Plant's Nuclear Emissions

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ABSTRACT. Possible associations between adult leukemia incidence and proximity-based surrogate measures of potential for exposure to radioactive emissions from the Pilgrim nuclear power plant in Plymouth, Massachusetts, were investigated. Included in this study were 105 nonchronic lymphocytic leukemia cases, diagnosed between 1978 and 1986 at age 13 y or older, that occurred in 22 towns near Pilgrim; population controls numbered 208. Residence within 4 mi (6.4 km) of Pilgrim during "high-emissions" years was related to case-control status (adjusted odds ratio [OR] = 3.88, 95% confidence interval [95% CI] = 0.81–10.64). A high "exposure" score (i.e., a value that accounted for downwind time) was also related to case-control status (OR = 3.46, 95% CI = 1.50–7.96). Some statistically significant dose-response trends were found. Cautious interpretation of associations is warranted in light of the low levels of reported emissions.

CITIZEN concern about potential health effects of living near nuclear facilities, as well as reports of elevated cancer rates near such plants, have served to instigate epidemiologic research. Results of early ecological analyses[1–4] were mixed; positive findings originated mainly from the United Kingdom, where attention was focused on childhood leukemia occurrence near fuel-reprocessing plants (i.e., Sellafield [England] and Dounreay [Scotland]).

A second wave of investigations was sparked by Gardner et al.,[5] who, in a case-control study, observed that a father's preconception radiation dose was related to leukemia occurrence in children born near Sellafield. The resulting controversial causal hypothesis did not appear to explain excess childhood leukemia near other nuclear plants in Great Britain.[6,7] Also, no association was found between father's preconception radiation exposure and childhood leukemia in regions of Ontario that were located near operating nuclear facilities.[8]

In the United States, data were analyzed by Jablon et al.,[9] who matched counties containing nuclear facilities to counties lacking such plants, and they failed to demonstrate a general increase in cancer mortality in U.S. counties that housed or were near nuclear-powered electric plants. Furthermore, Hatch et al.[10] found no relationship between adult leukemia or all childhood cancers and either routine or accident emissions from the Three Mile Island plant; only weak evidence was found that linked emissions to childhood leukemia. Multhead,[11] however, who noted the study's low statistical power and susceptibility to misclassification from unaccounted-for migration, found the results predictable and called for analytical incidence studies of nuclear-plant neighbors who apparently had experienced elevated risks.

In this article, we present the results of the Southeastern Massachusetts Health Study[12] (SMHS). The SMHS was a case-control study, which was conducted by the Massachusetts Department of Public Health (MDPH) at

the state legislature's request on behalf of concerned citizens. The study was designed to test the hypothesis that leukemia incidence between 1978 and 1986 near the Pilgrim nuclear power plant in Plymouth, Massachusetts, was related to residential proximity to the plant and to other proximity-based surrogate measures of potential for exposure to the plant's radioactive emissions. Given the need to collect different information for young children (whose parents' exposures would be of interest) versus older individuals, interview data to date have been collected only for subjects who were over age 12 y at the time of diagnosis. The results reported here pertain only to this case series.

Descriptive analyses, in which Massachusetts Cancer Registry (MCR) data for the 1982–1984 period were used, had shown that adult leukemia incidence was elevated for Plymouth and for four towns to its north.[23] Nonetheless, comparisons of leukemia rates among towns grouped on the basis of proximity alone had failed to reveal any evidence of a relationship.[24]

Material and Method

Eligible cases included all persons who, during the period between 1978 and 1986, were residing in any 1 of 22 southeastern Massachusetts towns during the time they were diagnosed with leukemia (other than the chronic lymphocytic cell type). All towns were in Plymouth County; however, towns were included only if their populations were entirely or mostly contained within a circle of radius equal to 22.5 mi (36 km), centered on Pilgrim (Fig. 1). Four qualifying towns in Barnstable County (i.e., on Cape Cod) were excluded because they were included in a cancer study that was conducted concurrently with the SMHS.

Cases diagnosed before 1982 were determined from

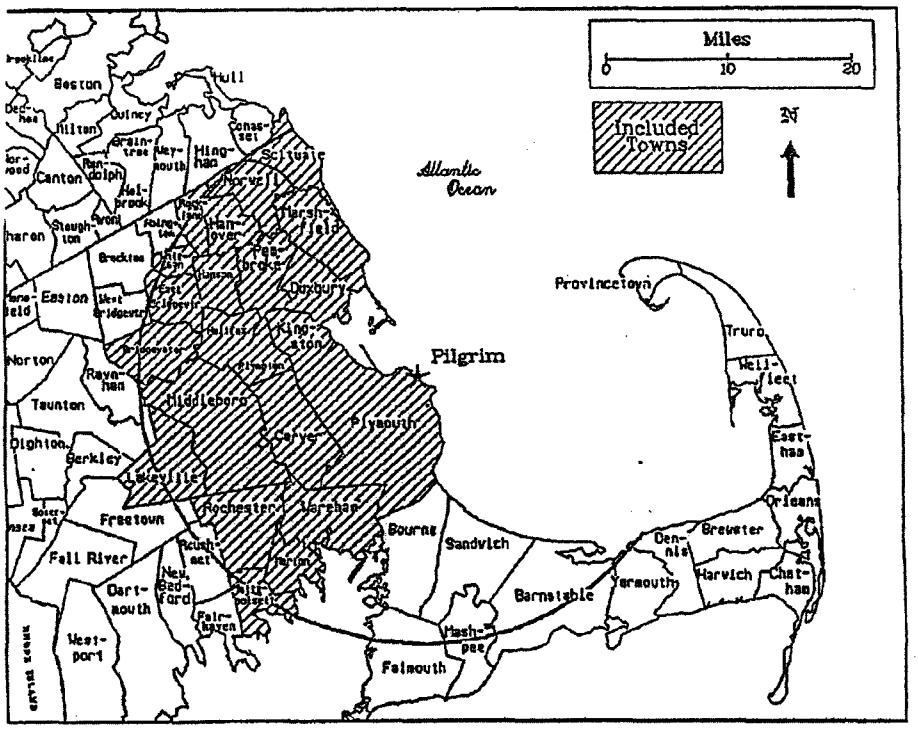

Fig. 1. Study area, showing the Pilgrim plant and the included/excluded towns within a 22.5-mi (36-km) radius.

tumor registrars or record keepers at 25 area hospitals that had ever reported leukemia cases from the 22 towns to the Massachusetts Cancer Registry (MCR) since its founding in 1982. Five additional hospitals located on the outskirts of the 22-town area were also contacted, but two refused to participate, and three reported no cases. Given that several hospitals were unwilling to re-ascertain cases diagnosed during the years of mandatory reporting to the MCR, the registry constituted a major source of cases diagnosed after 1981.

Those cases who had been diagnosed between 1982 and 1984 and who had resided in Plymouth, Kingston, Duxbury, Marshfield, and Scituate (i.e, 27 of the 115 cases over age 12 y ascertained by the SMHS), had been used previously to demonstrate excessive leukemia incidence near Pilgrim.[23,24] Two controls were matched to each case for age (within 5 y), sex, vital status, and year of death; in addition, each control must have been residing in 1 of the 22 towns during the same year the corresponding case was diagnosed with leukemia.

Controls for deceased cases (i.e., 88.6% of all cases) were selected by a stratified random-sampling procedure from a printout provided by the Massachusetts Registry of Vital Records and Statistics. All individuals were listed who had died of nonexcluded illnesses between 1978 and 1987 and who were permanent residents of the 22-town area. Excluded illnesses were those suspected of being associated with diseases or exposures under study (i.e., leukemia; chronic obstructive lung disease; tuberculosis; and cancers of the mouth, larynx, pharynx, esophagus, lung, pancreas, kidney, or bladder).

Controls for living cases were all over age 15 y, and all were selected randomly from the 1987 or 1988 town street directories. In accordance with state law, all town residents over age 16 y are listed in these directories. Four controls were selected for each case to help ensure the availability of 2 eligible participants from the original 4. Alternates in case-control sets in which the 2 first-choice controls had agreed to participate were not pursued unless needed to replace controls for cases for whom all 4 potential controls had been depleted.

Historical data pertaining to residence, occupation, health, and sociodemographics were collected from the subjects or their surrogates (when subjects were deceased) during a 45-min telephone interview conducted by trained staff. Introductory letters were sent to prospective respondents (i.e., case, control, or surrogate respondent) at least 10 d prior to the date of attempted telephone contact. In each letter, the aims of the study and data-collection process were explained, and respondents were advised about the types of questions that would be posed to them during the interview. Blank residential- and occupational-history forms were sent with the letters to encourage respondents to recall or obtain the required information before the interview.

Although the controversy surrounding plant safety had been covered by local media (as had the start of this health study), a conscious effort was made during communications with respondents to avoid mention of the outcome under investigation and the exposure of interest. More specifically, the study was introduced merely as a health survey, and no mention was made in letters or scripts of leukemia, nuclear power, or the Pilgrim plant.

To keep interviewers blind to case-control status, we devised a coding scheme to distinguish cases from controls; however, many respondents were interviewed by individuals familiar with the study design and coding scheme. The interview began by ascertaining the subject's address during the case's diagnosis year, followed by a request for a list of all addresses at which the subject had resided during the preceding 40 y. With respect to each address listed, the following were noted: year the subject had moved to the residence, number of years at residence, and details about the home and the neighborhood during the subject's residence there. If there were any gaps in history, individuals were asked to focus on their own ages and the ages of their relatives during the period in question.

Potential for exposure to airborne radioactive noble gases emitted from Pilgrim was determined via two crude surrogate methods. In the first method, residential proximity to the plant between 1974 and 1977 (i.e., years of higher-than-normal radioactive releases) was used as the exposure-potential index. The distance used for individuals (6% of all subjects) who had occupied multiple residences during that time period was a weighted average of the distances applicable to all qualifying addresses. In a four-category parameterization of the proximity variable, 4 mi was selected arbitrarily as the cutoff point between those with the highest potential for exposure and those with less exposure potential. The other cutoff points corresponded to the 25th and 75th percentiles of the residential-proximity distribution.

Exposure was also assessed by a score, calculated from each individual's residential and worksite histories and meteorologic and emissions data supplied by plant officials. The inverse square law[26,27] was applied to the distances between the plant and each residence and worksite occupied for at least 3 mo during the period of interest. The resultant terms were weighted by factors representing (a) the proportion of time typically spent at work (1/3) and at home (2/3), (b) the percentage of time each location was downwind of Pilgrim during the specified year, and (c) the extent to which reported emissions of noble gases for the year exceeded a "normal" level. In all years, except for the mid-1970s, emissions of radioactive noble gases were kept at or below 1 000 TBq,[28-30] which was considered "normal" for exposure-assessment purposes. Levels reported during the mid-1970s ranged from 2 000 to 15 000 TBq. Annual emissions-weighting factors equaled the amount of radioactivity (in TBq) in the form of noble gases emitted in a given year divided by 1 000. Annual exposure scores were summed over the years of interest to yield each individual's summary exposure score. Unbiased division of the continuum into four categories was

accomplished by establishing cutoff points at the 25th, 50th, and 75th percentiles of the distribution. The scores were not intended to represent radiation doses; instead, they were used to provide a proximity-based—but more refined—alternative to residential proximity alone as a crude surrogate for exposure.

Risks were estimated by conditional logistic regression, as performed by the proportional-hazards general linear modeling program of the Statistical Analysis System (SAS).[31] Candidate terms for the final model were selected a priori and included terms for work in a priori-specified "high-risk" occupations and industries, work in occupations and industries associated with leukemia risk in this data set, cigarette smoking, and socioeconomic status (SES). The stratification of SES was accomplished using Hollingshead and Redlich's method,[32] which is a numerical scoring system in which values are assigned to educational level and occupation, after which they are combined via a simple formula into an index of social position.

To account for induction time, we ignored the portion of the subject's (case's or control's) history that occurred within 5 y of the case's leukemia diagnosis. To determine whether control replacement and the use of deceased controls had biased the comparison group geographically, we compared the proportion of the 208 participating controls that had resided in each town during the matched case's diagnosis year to the town-specific proportion of the 22-town population (i.e., the sum over the 22 towns of the averages of the towns' 1980 and 1985 populations). We grouped towns into zones, based on proximity to Pilgrim, so that group comparisons could also be made. Towns that did not fit entirely into a zone were assigned to the zone to which most of the town's population was attributable. The population of Hanson, which was bisected by a demarcation line, was split between two zones.

Results

Ascertainment of cases. A total of 115 cases of nonchronic lymphocytic leukemia were ascertained for the 1978–1986 period. Forty-three cases had been diagnosed between 1978 and 1981, and 72 had been diagnosed between 1982 and 1986. The majority (70%) had myelogenous cell types, and the remaining 30% was split approximately equally between acute lymphocytic-type leukemia and rare or unclassifiable forms.

Response rate. Interviews were completed successfully for 105 (91%) of the 115 cases of nonchronic lymphocytic leukemia ascertained. Prospective respondents for 313 controls were contacted to complete 208 control interviews (control response rate = 66%), resulting in 2 matched controls for each of the 103 (of 105) cases and 1 matched control for each of the remaining 2 cases. Sixty-four percent of the nonresponses reflected a refusal to be interviewed; 34% resulted from the failure to locate a subject or a surrogate respondent.

Control distribution versus expectation. The proportion of participating controls that resided in each town and in each proximity grouping (or zone) during the matched case's diagnosis year (Table 1) was similar to the corresponding proportion of the 1980–1985 22-town population.

Potential confounders and matching factors. Cases and controls were well matched with respect to matching factors (Table 2). Relaxation of the vital-status matching criterion for young subjects, however, biased the control group slightly toward living subjects. Despite the stricter residence requirements imposed on controls versus cases by the sampling frames, controls resembled cases according to various indices of residential history in the study area. A statistically significantly greater percentage of controls versus cases had smoked, and a statistically significantly greater percentage of cases versus controls had been employed in a priori-specified "high-risk" occupations or industries (i.e., those that afforded opportunity for exposure to chemicals, fumes, or radiation).

Stepwise selection of model terms. Terms that added significantly to a model that already included terms for proximity or for the Pilgrim-exposure score were those that pertained to work history and cigarette smoking. Terms for SES did not add to the model, and their removal did not alter main-effect estimates.

Results of proximity-based analyses. The ORs relating leukemia risk for all subjects to residential proximity to Pilgrim (Table 3) were consistently greater than 1.0 and tended to increase as proximity to Pilgrim increased. The small group of subjects that had resided within 4 mi of Pilgrim had 3.88 (95% CI = 0.81–10.64) times the leukemia risk of those who had lived ≥ 23 mi from Pilgrim.

Results obtained for males were similar to results obtained for females, the only exception being the magnitude of the OR associated with the highest exposure-potential category (i.e., 5.14 [95% CI = 0.31–84.17] for males and 3.46 [95% CI = 0.50–23.73] for females). None of the individual ORs were statistically significantly greater than 1.0, but, for the full data set, the ORs increased significantly as proximity to the plant increased. Results of distance-based analyses were generally similar for two separate time periods (Table 4), during each of which approximately half the cases were diagnosed.

Results of score-based analyses. We also used the exposure score as an index of exposure potential (Table 3), and all ORs exceeded 1.0 when effects of higher exposure potential were compared with effects of lower exposure potential. Furthermore, when data for all males and females were combined, we observed a statistically significant linear trend in the ORs, and 95% CIs for ORs excluded 1.0. Although all relative risk estimates for males exceeded 2.0—and CIs excluded or nearly excluded 1.0—a linear trend was not obvious. The ORs estimated for female subjects, however, exhibited a strong linear trend, and individuals with the highest exposure scores had a statistically significantly greater risk of leukemia (OR = 5.19, 95% CI = 1.83–15.70) than did individuals with the lowest exposure scores.

Table 1.—Distribution of the 208 Participating Controls, by Town of Residence for Cases at Time of Diagnoses (y) Versus the Source Population*

Proximity Zone†	Miles between zone boundary and Pilgrim	Town‡	Population (%)	Controls (%)
1	≤ 8.0	Plymouth	14.1	13.0
2	8.1–13.2	Carver	2.7	3.8
		Duxbury	4.5	2.9
		Kingston	2.9	2.4
		Marshfield	7.8	9.1
		Plympton	0.8	0.5
		Total	18.7	18.7
3	13.3–17.0	Halifax	2.1	1.0
		Hanson (eastern)	1.6	0.0
		Pembroke	4.9	5.8
		Wareham	7.1	9.6
		Total	15.7	16.4
3	> 17.0	Bridgewater	7.3	5.3
		East Bridgewater	3.8	3.4
		Hanson	4.2	4.8
		Hanson (western)	1.6	3.8
		Lakeville	2.4	3.8
		Marion	1.6	1.9
		Mattapoisett	2.2	3.4
		Middleboro	6.2	5.8
		Norwell	3.4	3.8
		Rochester	1.2	1.4
		Rockland	5.9	5.8
		Scituate	6.7	5.3
		Whitman	5.0	3.4
		Total	46.5	48.5

*Town-specific 1980/1985 average population aged ≥ 13 y.
†Proximity zones were defined by drawing concentric circles around Pilgrim.
‡A town's assigned zone was the zone that contained most of its population.

Discussion

Our findings were generally supportive of the hypothesis that the diagnosis of adult nonchronic lymphocytic leukemia between 1978 and 1986 in southeastern Massachusetts was related to both residential proximity to Pilgrim during the "high-emissions" years and to a score designed to account for residential and worksite proximity and downwind time for the plant's entire operating history. Several factors, however, do not support a causal interpretation of these unexpected results. Among such factors is the Nuclear Regulatory Commission's estimated dose of 120 person-rem for the 22-town population, resulting from Pilgrim's 1972–1981 reported radioactive releases.[33] This estimated dose represents an elevation over background levels, the possible effect of which has been likened to that of residing in Denver, Colorado (e.g., at high altitude) versus Boston.[34] Consequently, without hypothesizing unreported emissions, a radionuclide-concentrating mechanism, or a previously unknown effect of exposure to low levels of ionizing radiation, the associations described here could not be explained by Pilgrim's radioactive releases. Although in some studies leukemia occurrence has been linked to residence near nuclear plants,[3,5–10,15] interpretation of these studies has remained very controversial.[35] Furthermore, the bulk of the research focused on childhood leukemia, and, in most cases, the facilities in question released high levels of radioactivity from nuclear-fuel reprocessing. Sellafield—the most studied of the plants—also experienced a major accident. There have also been problems at Pilgrim, but the plant had been cited by the Nuclear Regulatory Commission for management problems (and not radioactive releases),[36] and a proposed wind-mediated radionuclide-concentrating mechanism[23,25] has failed to garner support from the scientific community.[37,38]

The highest ORs reported were obtained from comparisons involving small numbers of exposed subjects. Furthermore, results of subgroup analyses tended to vary somewhat, depending on the category cut points used.

We considered the estimation of individual radiation doses to be beyond the scope of this state-funded study; nevertheless, there was potential for misclassification from the use of crude surrogate measures, thus

Table 2.—Case-Control Comparisons: Matching Factors and Other Attributes

Factor	Cases (n = 105) No.	%	Controls (n = 208) No.	%
Gender				
Male	64	61.0	126	60.6
Female	41	39.0	82	39.4
Vital Status				
Living	12	11.4	34	16.3
Deceased	93	88.6	174	83.7
Age (y)				
13–18	6	5.7	5	2.4
19–24	5	4.8	12	5.8
25–39	10	9.5	23	11.1
40–54	20	19.0	34	16.3
55–69	26	24.8	62	29.8
70–84	26	24.8	55	26.4
≥ 85	12	11.4	17	8.2
Mean age (*SD*)*	59 (21.7)		59 (20.4)	
SES† percentile				
Below 25th	25	23.8	50	24.0
25th–75th	52	49.5	108	51.9
Above 75th	26	24.8	50	24.0
Unknown	2	1.9	0	0.0
Cigarette smoking‡	54	51.4	128	61.5
"High-risk" work history§	40	38.1	50	24.0
Residence in study area since plant start-up	75	71.4	150	72.1
Mean y in area (*SD*)*	18 (12.7)		19 (11.4)	
Residence in one zone since start-up	71	67.6	135	64.9
Number of addresses occupied within 40 y of case diagnosis				
< 4	59	56.2	107	51.4
4–5	26	24.8	52	25.0
> 5	20	19.0	49	23.6
Number of jobs held within 40 y of case diagnosis				
0	11	10.5	26	12.5
1–2	50	47.6	96	46.2
3–4	29	27.6	56	26.9
≥ 5	15	14.3	30	14.4

*$p > .05$ for t test comparing means.
†SES determined by Hollingshead Index.
‡Cases were less likely to have smoked than controls ($p < .05$).
§Cases were more likely than controls ($p < .05$) to have been employed for ≥ 6 mo in a job or industry likely to result in exposure to chemicals, fumes, or radiation.

constituting a major methodologic weakness. To model exposure potential, we relied—as have many others—on plant proximity; only crude attempts were made to factor in meteorologic and emissions data, and certain variables (e.g., terrain, elevation) were ignored, even in the scoring system. Another potential source of misclassification bias was the reliance on self- and surrogate-reported data. Although inaccurate reporting of residence was unlikely,[39] misclassification of occupation and/or SES might have effected incomplete control of confounding by these factors. Gender differences noted in results gleaned from score-based analyses may have reflected misclassification of males because of their greater tendency to have worked, compared with females.

We assumed a 5-y latent period for leukemia after radiation exposure. This implied that subjects were considered unexposed if their entire period of residence near Pilgrim had occurred within 5 y of diagnosis. If the latent period was often shorter than 5 y, subjects may have been misclassified. The potential for misclassification of residence was limited, however, because of the brief period of interest (i.e., 1972 to 5 or 2 y before diagnosis). Only 11 cases and 13 controls would have been classified differently with respect to residence during the "high-emissions" years under a 2-y versus 5-y latency assumption. Crude analyses in which case-control status was related to residential proximity during the mid-1970s revealed higher values for 11 of 15 ORs calculated under a 2-y latency assumption; only 1 value was found to be lower.

The following three design features could have resulted in spuriously elevated ORs that related plant proximity to case-control status: (1) exclusion of Cape Cod cases from the study, (2) heavy reliance on MCR data for case finding, and (3) use of a geographically limited selection of hospitals. Hospital and MCR data and population figures lead us to suggest that, had the four qualifying Cape Cod towns been included, ORs ratios would have been lower than reported. Such ecological comparisons can be misleading, however, because they are based on aggregate statistics, which can be inaccurate, and because they ignore the influence of potentially confounding factors. Furthermore, although news reports of elevated cancer rates near Pilgrim—and the hypothesis that Pilgrim was the cause—might have resulted in geographically biased reporting of leukemia cases to the MCR, neither reviews of leukemia death certificates nor analyses of discharge data from hospitals not used for case finding provided evidence of biased ascertainment. Also reassuring was the fact that 91% of the nonchronic lymphocytic leukemia cases, that were from the MCR as 1982–1986 diagnoses attributable to the 22-town area, were diagnosed at a major Boston hospital, a Brockton hospital, or at one of three southeastern Massachusetts hospitals; all of these hospitals were included in the case-finding effort.

Bias could also have been introduced by the use of a deceased control group, by the imposition on controls (but not cases) of a 1987–1988 22-town residence requirement, and by low response from controls. It was clear from the smoking data that use of deceased controls resulted in case-control differences. It has been demonstrated previously that an unhealthy lifestyle (particularly one that features cigarette smoking) is associated with premature death.[40] This does not automatically imply, however, that deceased controls would be different from the target population in every important respect. Results of our comparison of the geographic distribution of controls to the distribution of the 22-town population supported the contention that the con-

Table 3.—Relative Risk* of Leukemia, by Distance from Pilgrim During High-Emissions Years, and by Pilgrim-Exposure Score

Subjects	Distance-based analyses: Distance (mi)	Cases (n = 105)	Controls (n = 208)	OR	95% CI	Score-based analyses: Exposure score	Cases (n = 105)	Controls (n = 208)	OR	95% CI
Males and females†	≥ 23.0	21	57	1.00		≤ 0.04	16	61	1.00	
	13.0–22.9	52	109	1.44	0.68–3.01	0.04–0.28	28	46	2.12	1.02–4.39
	4.0–12.9	27	39	2.25	0.96–5.63	0.29–0.72	30	55	2.77	1.20–6.39
	< 4.0	5	3	3.88	0.81–10.64	≥ 0.73	31	44	3.46	1.50–7.96
Males	≥ 23	12	33	1.00		≤ 0.04	9	37	1.00	
	13.0–22.9	32	65	1.53	0.53–4.40	0.04–0.28	18	25	2.61	0.98–6.97
	4.0–12.9	18	27	2.29	0.71–7.37	0.29–0.72	20	33	3.19	1.08–9.39
	< 4.0	2	1	5.14	0.31–84.87	≥ 0.73	17	31	2.83	0.95–8.41
Subtotal		64	126				64	126		
Females†	≥ 23.0	9	24	1.00		≤ 0.04	7	24	1.00	
	13.0–22.9	20	44	1.32	0.45–3.88	0.04–0.28	10	23	1.53	0.49–4.73
	4.0–12.9	9	12	2.31	0.62–8.70	0.29–0.72	10	22	2.16	0.56–8.23
	< 4.0	3	2	3.46	0.50–23.73	≥ 0.73	14	13	5.19	1.83–14.70
Subtotal		41	82				41	82		

*Odds ratio (OR), adjusted for the matching factors, cigarette smoking, and "high-risk" work.
†$p < .05$ for test for linear trend over distance and score categories.
‡$p < .05$ for test for linear trend over score categories.

Table 4.—Relative Risk* of Leukemia, by Distance from Pilgrim During High-Emissions Years and Time Period

Distance (mi)	1978–1982† Cases (n = 52)	Controls (n = 104)	OR	95% CI	1983–1986† Cases (n = 53)	Controls (n = 104)	OR	95% CI
≥ 23.0	14	31	1.00		7	26	1.00	
13.0–22.9	21	50	1.18	0.37–3.72	31	59	1.72	0.64–4.58
4.0–12.9	15	22	2.13	0.62–7.31	13	17	2.44	0.74–8.09
< 4.0	2	1	5.21	0.35–77.82	3	2	3.46	0.50–24.05

*Odds ratio (OR), adjusted for the matching factors, cigarette smoking, and "high-risk" work.
†$p > .05$ for test for linear trend over distance categories.

trol group was not biased geographically. Furthermore, most case-control comparisons provided evidence against the hypothesis that case and control groups differed; the two groups resembled each other with respect to SES, number of job changes, and residential history. On the other hand, controls were less likely than cases to have been employed in "high-risk" jobs or industries. However, the specific jobs and industries responsible for this difference (i.e., driving; precision production work; and employment in the transportation, leather, and shoe industries) implied a causal association, rather than bias.[41]

Possible leukemia correlates, other than exposure to Pilgrim's radioactive releases, that might have varied geographically included exposure to pesticides sprayed on cranberry bogs, exposure to radiation from medical procedures, exposure to electric and magnetic fields, and exposure to environmental pollutants other than radiation. A term for potential exposure to cranberry bogs (parameterized as "residence within half a mile of a bog") did not enter multivariate models. Nor did a term that crudely accounted for medical radiation exposure (i.e., number of radiographic procedures weighted for exposure differences among different types of procedures). Both terms, however, were derived from interview data that could have been inaccurate for these variables. We did not collect data on other sources of radiation or on other environmental pollutants.

Finally, we address the questionable practice discussed by Black[42] and MacMahon[35] of selecting study areas based on prior information regarding disease occurrence. Although this research may not have been undertaken had Clapp et al.[23] not reported in 1987 that leukemia occurrence was elevated near Pilgrim, the hypothesis we addressed was generated by the British studies of the early 1980s—and not by the data of Clapp

et al. The data of Clapp et al generated a controversial hypothesis pertaining to the capabilities of sea breezes that we chose not to address. Instead, our goal was to apply a stronger study design (i.e., an analytical one) to the hypothesis that had been addressed previously only by the descriptive-level data of Poole et al.[24]

The methods employed in this investigation were superior to those used in many other studies of this problem, but the exposure-assessment scheme was still crude, and findings should be interpreted cautiously. We recommend analytic studies of populations that reside near other U.S. nuclear facilities and the use of more sophisticated exposure-assessment methods, when feasible.

* * * * * * * * * * *

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EXHIBIT F-3

HEALTH

Richard W. Clapp, Statement before the Southeastern Massachusetts Health Study Review Committee, June 26, 1992 [provided by author]

June 26, 1992

Statement before the Southeastern Massachusetts Health Study Review Committee

Richard W. Clapp, MPH, Sc.D.

Thank you for providing the opportunity for interested citizens and scientists to comment on the Department of Public Health's 1990 Leukemia Study. My name is Richard Clapp, and I am an epidemiologist employed by the JSI Center for Environmental Health Studies in Boston. As you may know, I was Director of the Massachusetts Cancer Registry during the 1980's when Dr. Sidney Cobb first brought the pattern of cancer around Plymouth to our attention. I would like briefly to trace the history of that revelation and the subsequent analyses of the disease patterns we have carried out up to the present. I will also comment briefly on the Department's Southeastern Massachusetts leukemia study and the critiques of it made by Boston Edison and its consultants.

First, Dr. Cobb, Dr. Chan and I examined the pattern of leukemia in the towns around Plymouth in the period 1982-1984 and noticed the striking coastal elevation, especially when focusing on the non-CLL types. Dr. Cobb's hypothesis was that emissions from the Pilgrim plant were carried back over populated areas by on-shore winds. We published these data and the exposure hypothesis in a letter to the Lancet in 1987. At about the same time, the Department was deciding to undertake a case-control study. Dr. Cobb and I strongly supported the decision to undertake the study and, in particular, the attempt to better characterize exposure by detailed analysis of the emissions data and the meteorologic conditions that may have occurred in the period of peak radiation releases.

As it turned out, the first phase of the meteorologic study was done by Spengler and Keeler Associates, but the second, more detailed assessment of exposure was not carried out. Additional information about workers at the Pilgrim plant, including maintenance and temporary workers, was discussed, but a full analysis of these data was never carried out. It is my view that these additional studies should still be conducted and may shed additional light on the extent of health problems associated with Pilgrim operations.

In parallel with the case-control study, Dr. Cobb and I investigated the pattern of infant mortality, neonatal mortality, congenital defects, leukemia mortality, leukemia incidence, thyroid cancer incidence, lung cancer incidence, lung cancer mortality, brain cancer incidence, and the incidence of bone cancer and several other types. I also looked at the pattern of leukemia compared to the pattern of rectal cancer in the towns closest to Plymouth and again confirmed the strong tendency of the leukemia cases to live near the coast and close to the power plant. Most of this work was done while I was still Director of the Cancer Registry collaborating with Dr. Cobb when he lived in Southeastern Massachusetts.

I would like to present a graphical assessment of the pattern of leukemia and thyroid cancer in the towns closest to the power plant during the period 1982-1989. These data are from the Cancer Registry, which has been and continues to be the most consistent source of accurate information about the pattern of cancer in Massachusetts during the 1980's. The data for 1989 cases

were provided to me as a public data request earlier this week, so they represent as complete a picture as is currently available. The graphs are attached to this statement and you will note that the incidence of leukemia peaked in 1982 and subsequently declined until 1986. Then there was a second, smaller peak in 1987 and 1988 which declined in 1989. The number of cases exceeded the number expected in 1982-85 and 1987-88. The second graph depicts the pattern of thyroid cancer in the same set of towns. This shows a peak in the years 1987-1988, although it is probably too early to determine whether the number of cases in 1989 represents the beginning of a decline back to the number expected, which is about three and a half cases a year.

We looked at several other types of cancer, most of which have a longer latency from exposure to radiation and have not discerned any similar patterns in the data to date, although the number of lung cancer cases bears close monitoring. Our conclusion from analysis of these descriptive data is that they are consistent with a radiation "footprint" in the population of the towns most likely to be exposed to radioactive emissions from the Pilgrim nuclear power plant. The pattern of thyroid cancer is particularly relevant to the radioactive iodine emissions reported in the 1974-1976 period. We have continued to monitor the pattern of cancer incidence in the towns around the power plant and maintain an on-going line of communication with several citizens groups. We expect to be involved in discussions of future studies as further resources and data become available.

Comments on the Southeastern Massachusetts Leukemia Study

Dr. Cobb was part of the scientific advisory group to the Department of Public Health Study and has made his views known to several members of this Review Committee. I will not attempt to reiterate his position other than to say that he generally supports the methods and findings of the case-control study and considers it important corroboration of the descriptive statistics we have compiled. He and I both have expressed disagreement with the definition of proximity of the cases to the coast, but that is a relatively minor issue compared to the main findings.

My own view of the case-control study is that it was carefully considered, well-conducted, and the available data have been thoroughly analyzed within the constraints of personnel and budget within the Department. I had many discussions with the principal authors and staff while I was at the Department and in the past three years since I have left. I believe that the criticisms raised by Boston Edison and its consultants have been largely theoretical and that when the actual data are evaluated, the validity of the study is undiminished.

Having said that, I would also acknovledge that the surrogate measure of exposure leaves much to be desired. The recommendations that actual exposure estimates, biomarker studies, and detailed meteorologic studies be carried out have my full support. I would also reiterate a point that Drs. Knorr and Morris made to you in one of their memoranda, e.g., that the emissions data provided by the utility are not reliable. I have had numerous discussions with individuals in the Department of Public Health as well as a colleague who previously worked in a job monitoring worker exposure to Pilgrim contractors in the mid-1970's. From these discussions, I am convinced that the actual emissions were considerably worse than what has appeared in public documents

and has been available to researchers to date. In particular, there were transuranic isotopes released that should never have been emitted to the general environment.

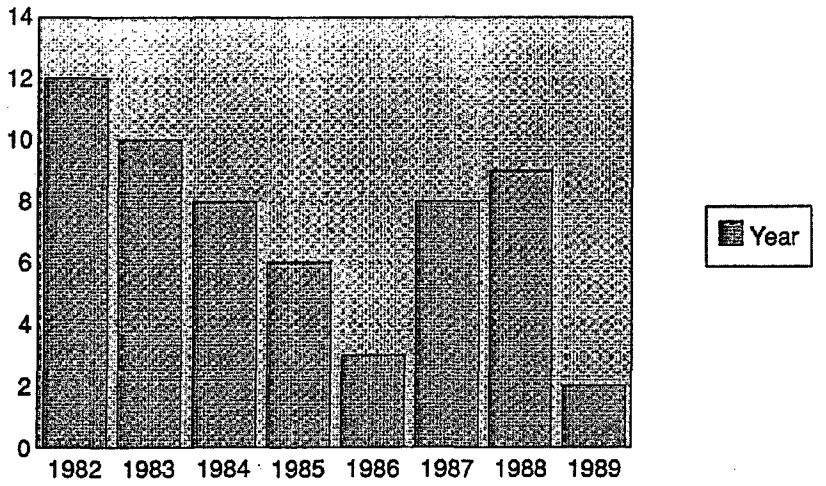
I would urge consultants to Boston Edison to be as thorough and detailed in their criticisms of the emissions data as they have been in their critiques of the case-control data if they are really interested in scientific truth. Their comments on the "implausibility" of the leukemia study findings rest almost entirely on highly suspect emissions data. It may be that relevant documentation of the extent of emissions has been destroyed, and one very public representative of the utility has said that the emissions in the mid-1970's occurred before he worked for the company so he could not vouch for the data. There are individuals in the Department of Public Health who told me that the actual situation was much worse than reported, and I have no doubt that there are others even closer to the situation, and whose jobs would not currently be on the line, who could be interviewed. In any case, a thorough investigation of this would be necessary before attempting to construct exposure estimates for study subjects. Other commenters have more to say on that topic and I will leave it to them to submit their information to you.

Conclusion

From a public health point of view, the magnitude of the suggested health effects from Pilgrim emissions is not enormous. In fact, Dr. Cobb testified before a committee of the State Legislature several years ago that the number of excess deaths in Plymouth area towns was probably greater due to motor vehicle accidents than to radiation-induced disease. This by no means diminishes the individual tragedies that are represented by the case reports and deaths due to leukemia and other diseases in the Plymouth area. On the other hand, the public policy implications of the associations are enormous and have implication far beyond this one plant and the affected families. It is vitally important that your review of this study be clear-headed and scientifically responsible. I urge you to endorse what has been done so far, to recognize the limitations of the data and resources available, and to use your report as an opportunity to recommend useful further research on this topic. For my part, I will also continue to work with the citizens groups and insist on responsible reporting of vital health data.

Leukemia (minus CLL) in Plymouth Area

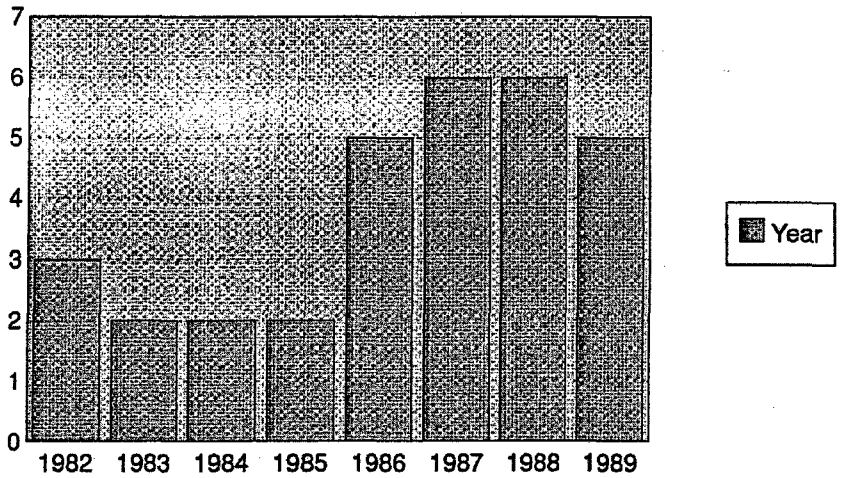
1982-1989



as of 6/25/92

Thyroid Cancer in Plymouth Area

1982-1989



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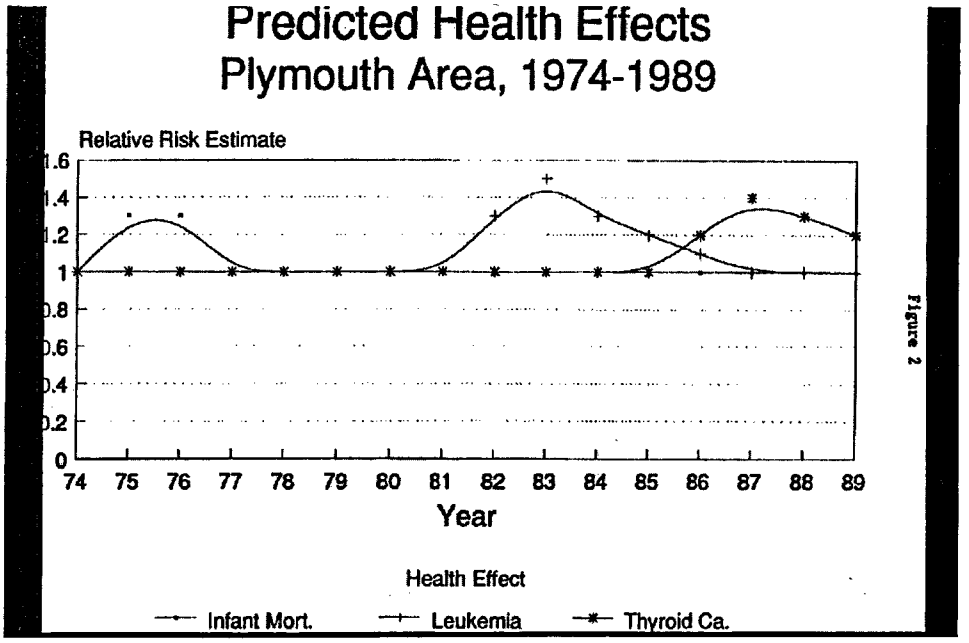

Predicted Health Effects
Plymouth Area, 1974-1989
Relative Risk Estimate
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89
Year
Health Effect
Infant Mort.
Leukemia
Thyroid Ca.

Figure 2

EXHIBIT F-4

HEALTH

Richard W. Clapp, Sidney Cobb, C K Chan, Bailus Walker, Leukemia near nuclear power plant in Massachusetts, Letter to Lancet, in Valerie Beral, Eve Roman, Martin Bobrow, Childhood Cancer and nuclear Installations, papers, abstracts, editorials, reports published since 1984, BMJ Publishing group, Tavisrock Square, London WC1H 9JR, 1993

CHILDHOOD CANCER AND NUCLEAR INSTALLATIONS

Papers, abstracts, letters, editorials, reports published since 1984
edited by

Valerie Beral and Eve Roman

Imperial Cancer Research Fund
Cancer Epidemiology Unit
Oxford University
and

Martin Bobrow

Paediatric Research Unit
Division of Medical and Molecular Genetics
United Medical and Dental Schools of Guy's and St Thomas's Hospitals
London

This book is dedicated to the late Martin J Gardner

Medical Research Council Environmental Epidemiology Unit
University of Southampton

Published by the BMJ Publishing Group
Tavistock Square, London WC1H 9JR

1993

45: Leukaemia near nuclear power plant in Massachusetts

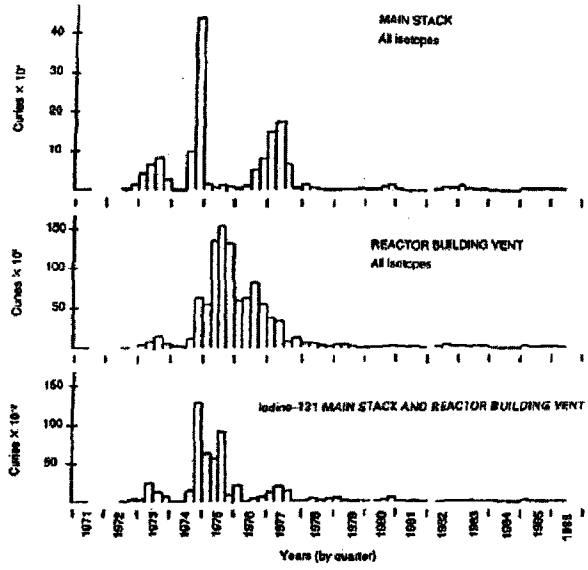
Letter to the *Lancet*

RICHARD W CLAPP, SIDNEY COBB, C K CHAN, BAILUS WALKER JUNIOR

Your 17 October issue (*Lancet* 1987; ii:924) carried a note about the latest review of cancer around nuclear installations in Britain. We observed an increased incidence of leukaemia, particularly myelogenous leukaemia, in a five town area in Massachusetts during the years 1982–84. One of those towns (Plymouth) is the site of a commercial nuclear power plant that began operations in late 1972 and from which releases of various isotopes in late 1974 and 1975 have been recorded (figure).

The standard incidence ratios for all haematopoietic and reticuloendothelial system (ICD 169) neoplasms, all types of leukaemia combined, and all types of leukaemia minus chronic lymphocytic leukaemia are presented in table I. The standard rates from which the standard incidence ratios were calculated are the statewide rates for Massachusetts for 1982–84. These are for all ages combined, although it is of interest that the excess was in adults and the elderly, not in those under 25 as noted in British data. The most striking excess was for myelogenous leukaemia in males.

We calculated age-adjusted morbidity odds ratios, comparing the incidence in the five coastal towns with that in the surrounding communities in south eastern Massachusetts. The rationale for this was that there might be a registration effect whereby patients from these towns might be more likely to be diagnosed and reported to the Massachusetts cancer registry than patients in the state as a whole. A further consideration is the fact that about 90% of the patients from the five town area and the rest of south eastern Massachusetts are captured in a regional registry system (Healthstat Inc). It might be argued that the diagnostic and coding conventions used by this regional registration system differed from those used in



Airborne radioactive effluents from Pilgrim I nuclear reactor in Plymouth, Massachusetts, by quarter, 1972–86. Source: Boston Edison semi-annual effluent reports to USNRC.)

hospitals elsewhere in Massachusetts, although we know of no evidence to support this. The odds ratios comparing the incidence in the five town area and the two comparison areas for the four year period 1982–85 are presented in table II. We conclude that a registration effect is not a plausible explanation for the apparent excess in the five town area for this time period.

As the nuclear power plant is on the coast and as the reported releases of radioactive effluents are too small to produce a doubling of myelogenous

TABLE I—*Incidence of haematological malignancies (ICD 169) in five Massachusetts coastal towns, 1982–84*

Diagnosis	Male	Female	Total
All*	31/18·1 (171)	21/15·2 (138)	52/33·4 (156; 118 to 206)
Leukaemia	22/12·1 (182)	12/9·3 (129)	34/21·4 (159; 113 to 224)
Leukaemia minus chronic lymphocytic leukaemia	19/9·4 (203)	8/7·6 (106)	27/16·9 (160; 108 to 237)
Myelogenous leukaemia	13/5·2 (252)	6/4·8 (126)	19/9·9 (191; 120 to 304)

*All haematopoietic and reticuloendothelial system neoplasms.
Results are shown as observed/expected (and standard incidence ratios, with 95% confidence intervals for totals).

TABLE II—*Adjusted odds ratios and confidence intervals for haematopoietic and reticuloendothelial system neoplasms in five coastal towns compared with south eastern Massachusetts and the state, 1982–85*

	South eastern Massachusetts	Massachusetts
Males	1·52 (35); 1·06 to 2·18	1·56; 1·09 to 2·20
Females	1·19 (28); 0·80 to 1·76	1·35; 0·93 to 1·98
Total	1·38 (63); 1·06 to 1·81	1·49; 1·15 to 1·95

Numbers in parentheses refer to nos of cases

leukaemia in residents of the towns, we must postulate a mechanism by which airborne releases are contained in a coastal pattern. Such a meteorological mechanism is well known to weather observers,[1] and, in this instance, could contain airborne effluents and recycle them over the immediate coastal area. No other series of towns along the Massachusetts coast has had similar increases in leukaemia or in the myelogenous subtype.

Clearly, more detailed modelling of the meteorological conditions in the mid-1970s is needed before dose estimates could be made. Nevertheless, these descriptive data are suggestive and will be followed up by more investigations and more intensive observation of cancer incidence trends around this and other US nuclear power plants.

1 Field F. *Dr Frank Field's weather book.* New York: Putnam, 1901.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the matter of
Entergy Corporation
Pilgrim Nuclear Power Station
License Renewal Application

Docket # 50-293

May 25, 2006

CERTIFICATE OF SERVICE

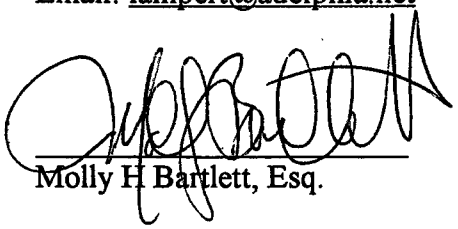
I hereby certify that the foregoing Request for Hearing and Petition to Intervene was sent this 25th day of May, 2006 via email and U.S. Postal Service as designated to each of the following:

Secretary of the Commission (Email and 2 copies via U.S Postal Service)
United States Nuclear Regulatory Commission
Washington, DC 20555-0001
Attention: Rulemaking and Adjudications Staff
Email: HEARINGDOCKET@NRC.GOV

Office of General Counsel (Email and U.S. Postal Service)
United States Nuclear Regulatory Commission
Washington, DC 20555-0001
Email: OGCMailCenter@nrc.gov

Mr. Terence A. Burke, Esq. (U.S. Postal Service)
Entergy Nuclear
1340 Echelon Parkway
Mail Stop M-ECH-62
Jackson, MS 39213

Mary Elizabeth Lampert (Email)
Pilgrim Watch
148 Washington Street
Duxbury, MA 02332
Email: lampert@adelphia.net



Molly H Bartlett, Esq.

5/25/06
Date

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the matter of
Entergy Corporation
Pilgrim Nuclear Power Station
License Renewal Application

Docket # 50-293

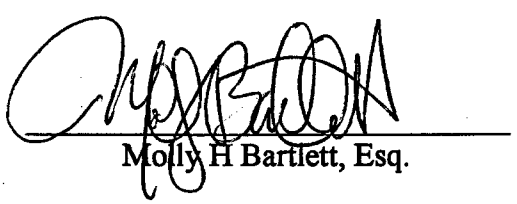
May 25, 2006

NOTICE OF APPEARANCE FOR MOLLY H. BARTLETT, ESQ

Pursuant to 10 CFR 2.314(b), Molly H. Bartlett, Esquire, hereby enters an appearance on behalf of Pilgrim Watch and provides the following information:

1. I am an attorney licensed to practice law in Massachusetts. My address is 52 Crooked Lane, Duxbury, MA 02332. My telephone number is 781-934-9473 and e-mail address is mollyhbartlett@hotmail.com.

2. I have been appointed by the petitioners to represent Pilgrim Watch in this proceeding.



Molly H Bartlett, Esq.

5/25/06
Date

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the matter of
Entergy Corporation
Pilgrim Nuclear Power Station
License Renewal Application

Docket # 50-293

May 25, 2006

NOTICE OF APPEARANCE OF MARY ELIZABETH LAMPERT

Pursuant to 10 CFR 2.314(b), Mary Elizabeth Lampert hereby enters an appearance on behalf of Pilgrim Watch and provides the following information:

1. I am Director of Pilgrim Watch at 148 Washington Street, Duxbury, MA 02332, Tel. 781-934-0389. My e-mail address is lampert@adelphia.net.

2. I have been appointed by Pilgrim Watch to represent the organization and its Massachusetts members in this proceeding.

Signed:

Mary Lampert

May 25, 2006
Date

Mary Elizabeth Lampert
148 Washington Street
Duxbury, MA 02332

May 26, 2006

Office of the Secretary
U.S. Nuclear Regulatory Commission
Washington, DC 20555–0001
Attention: Rulemaking and Adjudications Staff

Subject: Request for a Hearing and Petition to Intervene
Affidavit of Standing
Docket No. 50-293

Dear Mr. Secretary,

On behalf of Pilgrim Watch, I am enclosing an affidavit of standing of to be attached to the above referenced filing. The Request for a Hearing and Petition to Intervene by Pilgrim Watch was submitted to your office by electronic mail on Thursday, May 25, 2006 and by Express Mail to arrive Friday, May 26, 2006. If you have any questions or problems with regard to this Petition, please let me know immediately.

Very truly yours,

Mary Elizabeth Lampert

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the matter of
Entergy Corporation
Pilgrim Nuclear Power Station
License Renewal Application

Docket # 50-293

May 26, 2006

DECLARATION OF MARY ELIZABETH LAMPET
SUPPORTING STANDING OF PILGRIM WATCH

I, Mary Elizabeth Lampert, affirm the following to be true:

1. My name is Mary Elizabeth Lampert. I live at 148 Washington Street in the Town of Duxbury, Massachusetts. My husband James and I own our home and land at this address. We have lived here for over twenty years.
2. I believe that my house and land are approximately 6 miles from the Pilgrim Nuclear Power Station in Plymouth Massachusetts.
3. I am a member and director of Pilgrim Watch and would like Pilgrim Watch to represent my interests in the above captioned case because I have concerns about the license renewal of Pilgrim Nuclear Power Station.
4. Pilgrim Watch and I want to participate in hearings on that license renewal to decide whether the plant's operations are adequate to assure the safe operation of the nuclear plant for an additional twenty years without the public health and safety being compromised.

Mary Elizabeth Lampert

May 27, 2006
Date